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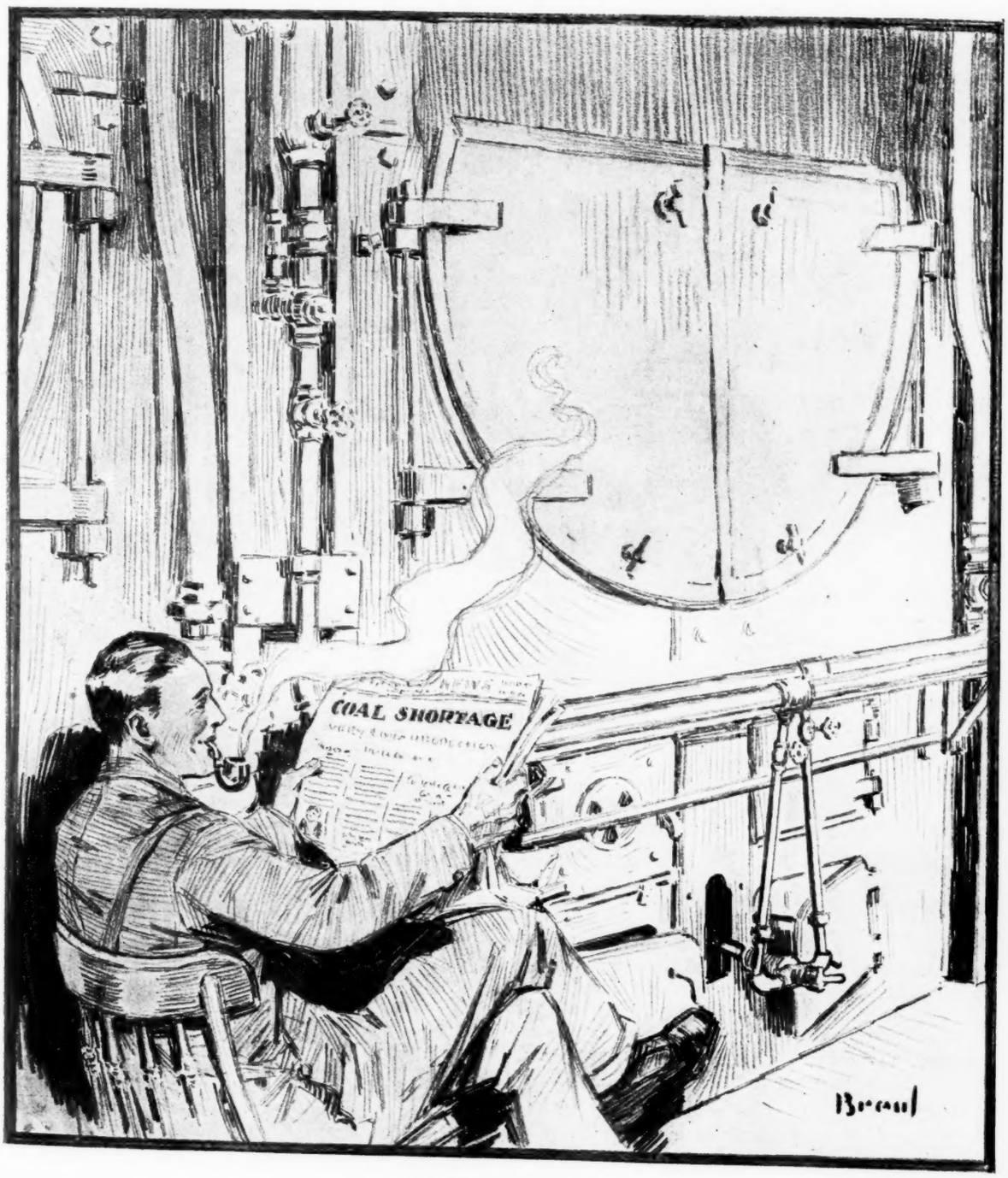


HE SHOULD WORRY

Lap Seam Boiler Explodes

Another explosion of a boiler as the result of a lap seam crack occurred at the power plant of the Sisters of St. Francis of Assisi, St. Francis, Wis., a suburb of Milwaukee, at about 10 o'clock Sunday evening, Nov. 2, 1919. The boiler was 60 in. diameter, 14 ft. long, and constructed of 3/8-in. plate of flange steel having a tensile strength of 60,000 lb. per square inch, as shown by the steelmaker's brand. There were two sheets of the shell plates, each sheet forming a complete ring with the longitudinal seam at the usual place, above the watre line. The boiler was built in 1904.

The longitudinal seams were of the double-riveted lap-joint type, there being two rows of 7/8-in. rivets driven in 15/16-in. holes. The rivet spacing being 3¼ in. gave a joint efficiency of approximately 71 per cent, the net section between rivet holes being the weaker. The spring loaded safety valve of this boiler was set to blow at 95 lb. pressure, giving the boiler at the maximum allowable pressure a factor of safety of 5.6.

The boiler that exploded as well as the other two boilers in the plant were examined on Sept. 22 by an insurance company inspector, and on the morning of Oct. 25 the engineer who has had charge of the plant for over eight years cleaned and examined the boiler and prepared it for service. The cleanliness of the boiler and its freedom from other defects indicated it had received good attention in every way.

From the information obtainable, it appears that boilers Nos. 1 and 3 were temporarily out of service, with the manhole plates removed, and boiler No. 2 was being used for supplying the lighting load and for heating the premises. On Nov. 2 the boiler was being operated as usual. At about 5 o'clock p. m. the pressure reached 95 lb., and the safety valve operated freely as it had done daily for a week or more previously. After the accident, the safety valve was found to be perfectly free and unobstructed.

FIG. 1. LAP SEAM BOILER EXPLOSION AT ST. FRANCIS, WIS.

At 8 p. m. of that day the fire was banked for the night, the steam having been shut off from the buildings and the electric lights switched to the storage battery. The pressure gage indicated 40 lb. pressure and the water stood at three gages. After locking up the plant the engineer left the premises. Two hours later the boiler exploded quite violently, demolishing the greater part of the boiler room building and damaging the laundry building wall adjacent to the boiler room. Boilers Nos. 1 and 3 were forced from their settings and parts of the boiler room equipment were projected to a distance of 400 or 500 feet. No one was injured by the accident. The property damage approximated $10,000.

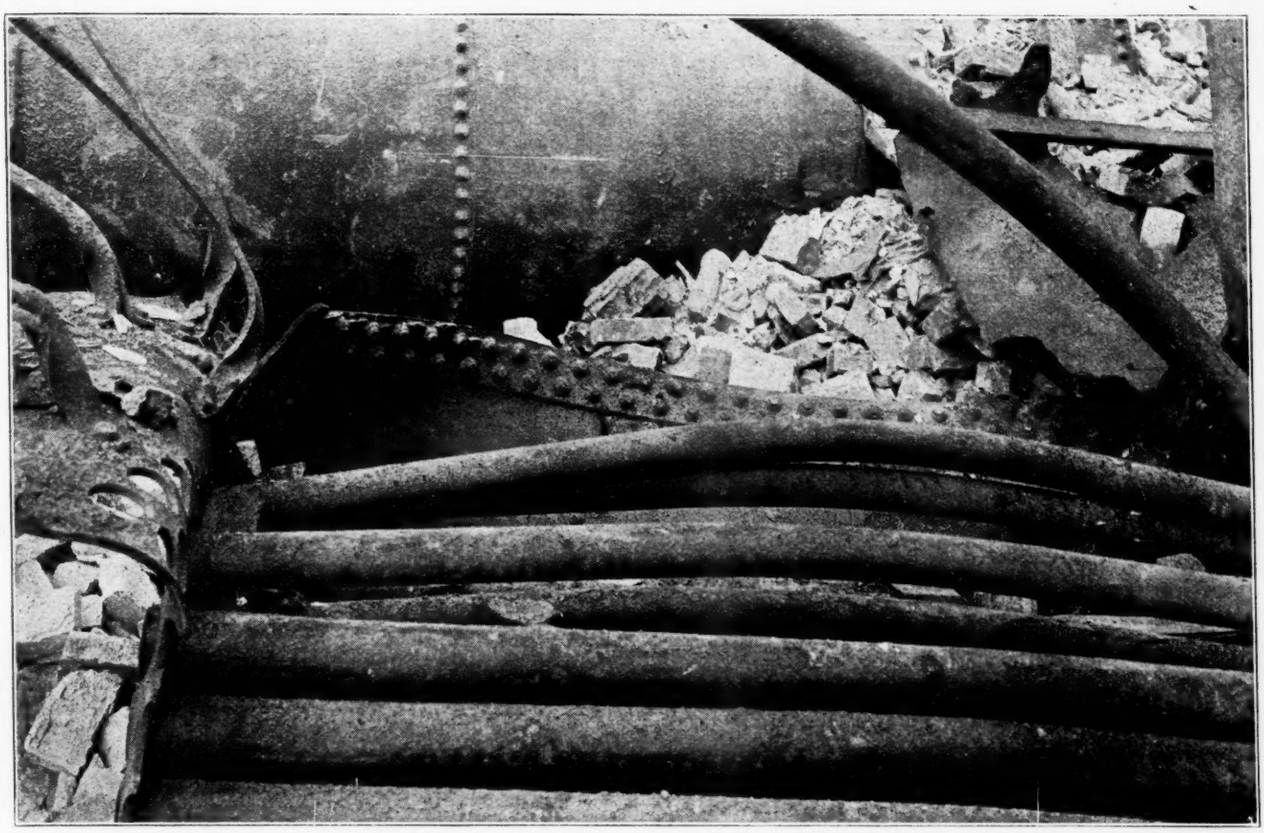


FIG. 2. CLOSE-UP VIEW OF RUPTURED SEAM

Examination of the exploded boiler developed the fact that the front course of the shell plate had failed from the head seam to the girth seam, a distance of 6 ft. 9 in., along the rivet holes of the double-riveted lap seam, as plainly seen on the "close-up" view of the sheet, Fig. 2. The crack probably started at a point about 5 ft. from the front head, where the plate was not homogenous, and gradually extended to the front head seam, working deeper into the sheet until separation occurred.

That part of the seam between the laminated spot which did not appear on the surface, and the first girth seam, contained no indications of an old crack, and by the reduction in thickness and elongation, the material would be judged to be of good quality. The seam had given no warning of its condition, as there had been no leakage, and in fact the boiler since its installation had never been repaired in any way.

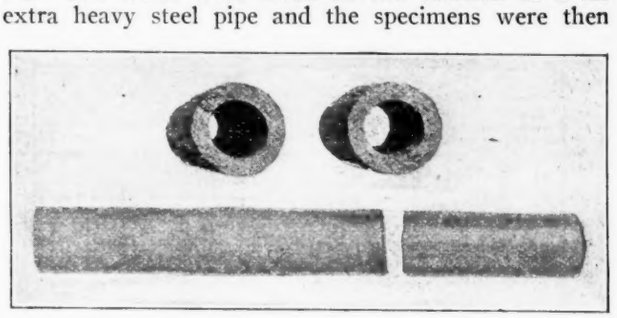
It will be seen from the photograph of the ruins, Fig. 1, that the force of the explosion was a clear indication of the amount of water contained, so that the low-water theory may be discarded. As is usually the case where the failure occurs above the horizontal diameter, the force was expended principally upward, and the boiler was moved but a short distance from its proper position. The banked fire remained on the grate of the dutch-oven furnace, the latter being practically intact.

Of course no one can state positively what took place after the fire was banked and the flow of steam from the boiler ceased, but those who have had to do with boiler operation will easily conclude that with hot furnace walls, a freshly banked fire, a boiler filled with water, and steam at 40-lb. pressure, and the steam produced no longer being used, there would be an increase in pressure which under certain conditions might reach the amount to which the safety valve is set, in this case, 95 pounds.

The boiler had safely withstood 95 lb. pressure at 5 o'clock, but had probably been on the verge of failure for several days.

Tensile Tests of Thermit Pipe Welds

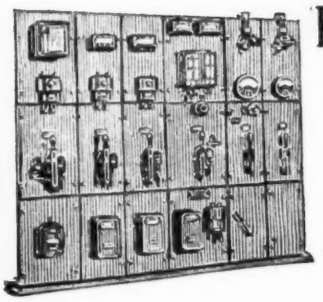
Two tensile tests of Thermit pipe welds were recently carried out for the Carnegie Steel Company, Clairton, Pa. The welds were made on two sections of 2 in. extra heavy steel pipe and the specimens were then



SECTIONAL VIEW OF FRACTURE

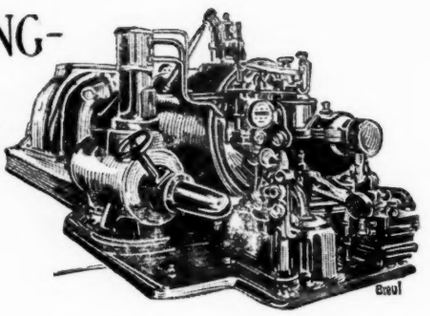
pulled on a tensile testing machine. The first pipe broke under a total load of 113,800 lbs. and the fracture was 4 in. from the weld. The second pipe broke 4⅝ in. from the weld under a load of 124,000 lbs.

The illustrations show a cross section of the fracture and a side view of the specimen giving the location of the fracture and of the weld on one of the pieces tested. Since the pipe did not break at the weld in either case the welds were evidently stronger than the pipe and the figures given are less than the breaking strength.



PUTTING AN ALTERNATING-CURRENT GENERATOR IN SERVICE

By
Frank Gillooly



The process of putting an alternating-current generator of medium size on the bus for the first time is discussed, and such features as drying out the windings, making insulation tests, phasing out the machine, division of load, etc., are considered.

PLACING a new unit in service is not a difficult job when the various operations are understood and the whole process is viewed from an operating standpoint. This article will consider the initial loading of a three-phase 60-cycle 2300-volt turbo-alternator of medium size, which is a representative unit. Three-phase distribution is the most economical system for power, which forms the bulk of the load on most plants; and 2300 volts is the bus potential of many private plants and small generating systems. The unit would probably run 1800 r.p.m., although 3600 r.p.m. is not an uncommon speed for turbines up to 2500-kv.-a capacity. The alternator in the former case would have four poles; in the latter case, two poles.

Alternators are now rated either in kilovolt-amperes (kv.-a.) or in kilowatts (kw.) at a specified power factor. An alternator rated 1000 kw. at 80 per cent. power factor, is equivalent to $1000 \div 0.80 = 1250$-kv.-a. machine. This rating is important, since it determines

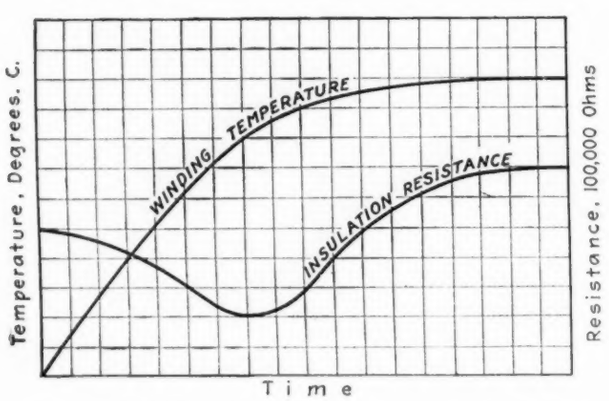


FIG. 1. TEMPERATURE AND INSULATION RESISTANCE CURVES

the full-load current of the generator and affects the voltage regulation.

Temperature indicators are usually connected into different parts of the armature winding or at some part of the machine where a reading may be obtained which, when increased by the factor representing the difference in heating between that point and the hot-test spot, usually 15 deg. C., if thermometers are used, gives the temperature indication. The maximum allowable temperature rise in insulation of the kind now used in alternators is 85 deg. C. and the maximum safe operating temperature 125 deg. C.

It may be desired to test the insulation, which has been guaranteed for certain standardized pressures by

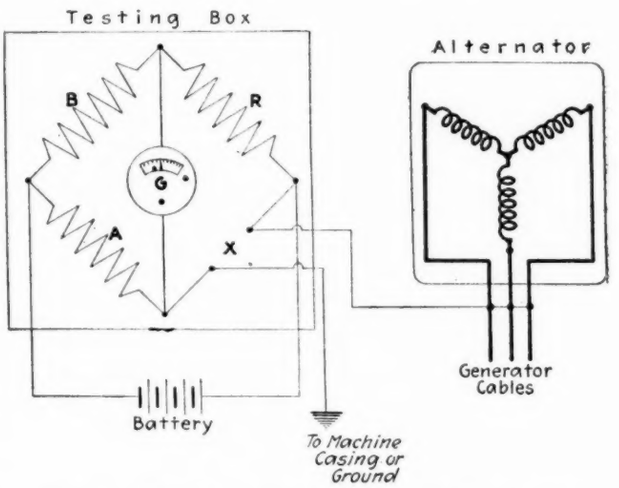


FIG. 2. TESTING INSULATION RESISTANCE WITH WHEATSTONE BRIDGE

the manufacturer, before the machine is placed in regular operation. Such tests are customary on all armatures, but are made only on the fields of large units or when necessary on small fields.

The field winding may be dried out by passing current through it. For this, leads must be run from a separate exciter or other direct-current source, through an ammeter and rheostat, to the terminals of the winding. Current not greatly exceeding full-load will be circulated through the winding until the heat of the conductors has dried their insulation. From time to time the resistance of the insulation and the temperature rise of the winding should be measured; and the drying-out will be continued until the resistance reaches its maximum value. A breakdown test may be made after the heat-run. It should be for approximately ten times the operating voltage of the winding, but never for less than 1500 volts or more than 3500 volts. After any heat-run a machine must not be allowed to cool too quickly, or its windings will "sweat" and become moist again.

On large machines assembled on the customer's premises, each armature coil is given an initial breakdown test when it is fitted into its slot. In the ma-

chine under consideration the armature would come completely assembled, and the breakdown test would be made on the whole winding after the armature heat-run had been made to dry it out and test its temperature rise.

When the unit has been assembled a mechanical inspection will be made to see that all bolts, nuts and joints are tight, that no tools are lying around or in the machine, that all scaffolding and forms have been removed, and that all ducts are clear. An electrical inspection is also made. The phase rotation of the alternator has been determined at the factory and all armature connections marked. All cables should be traced back to the bus and their connections checked. Connections are gone over with wrenches to insure good contact. Slip rings and brushes are cleaned and inspected and brush tension adjusted on the alternator, as well as on the separate exciter if the unit has one. The rheostats and their contacts and control should be inspected as should all control circuits, the field-break switch, and the governor motor. On the last the direction of rotation and the limit-switch cutouts should be tested. The instruments should be calibrated, the synchronizing circuits checked, the oil switch tried and its operating characteristics noted by the men who must use it in synchronizing. Meanwhile, steam will have been turned on and the unit rotated slowly to test the steam joints and seals for leaks. The machine is then ready for its heat-run.

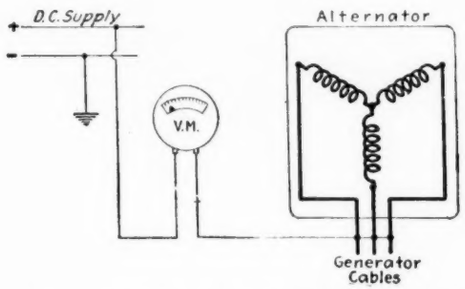


FIG. 3. TESTING INSULATION RESISTANCE WITH VOLTMETER

Making the Heat-Run Test

The heat-run is made by running the machine on dead short-circuit. Each phase of the armature is short-circuited through heavy cables capable of carrying the full-load current of the machine. These cables are connected on the machine side of the oil switch, or at the machine disconnecting switches if there are such. The short-circuit connection must always be made beyond the generator current transformers, so that the ammeters of the machine will be in circuit. The generator field-break switch is then closed, with all rheostat resistance in, preferably on a separate exciter at low voltage, and the speed and field excitation gradually increased until the armature is carrying full-load current. During the test the ammeters must be carefully watched to apprehend any further current increase due to increases in speed or exciter-voltage. Whenever it is desired to interrupt the test, the short-circuit must not be removed from the armature until after the field switch is opened, or there will be a dangerous voltage rise in the former if the machine is running.

The short-circuit, or heat-run, test is continued for twenty-four hours or more. From time to time the test is stopped to measure the insulation resistance and the temperature of the winding. Insulation resistance is always lower when hot than when cold. At first it will drop, then continue to rise until the point is reached at which it becomes constant. The value for the resistance of the insulation at operating temperaure given by the A. I. E. E. Standardization Rules, is

$$\textit{Resistance in megohms} = \frac{\textit{terminal voltage}}{\textit{kv.-a. rated capacity} + 1000}$$

and it should never be less than one megohm.

During the heat-run all apparatus should be inspected for loose connections and heating. The temperature rise of the armature must be studied, for it will govern the output of the machine when in regular operation. A curve may be drawn, as in Fig. 1, showing the temperature at intervals during the test. The insulation resistance at various temperatures may also be plotted on the curve. Care should be exercised in locating the thermometers. When placed against a part of the machine, the bulb must be covered with felt or putty to prevent cold air affecting the readings; and the bulb must never be lower than the tip or the mercury column may separate.

Measuring Resistance of Insulation

The resistance of the insulation may be measured with a megger, a Wheatstone bridge, or a voltmeter. The megger generates its own testing potential and reads directly in ohms, so that it need only be connected to the winding and to ground. The megger leads must be well insulated and the connections clean and solid, in order to secure accurate readings.

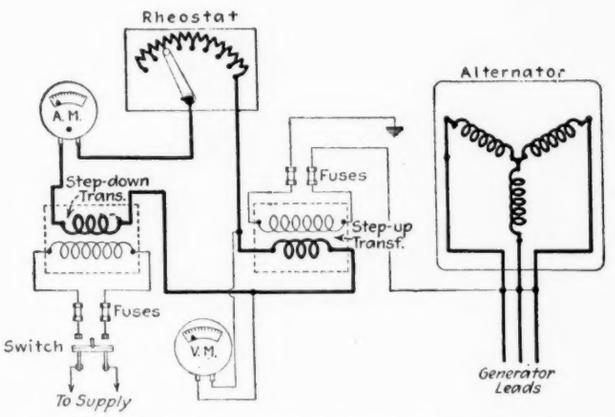


FIG. 4. CONNECTIONS FOR MAKING POTENTIAL TEST ON WINDING INSULATION

The Wheatstone-bridge set employs a battery potential to obtain a galvanometer deflection in a series-parallel circuit containing a number of known resistances and the resistance to be measured. The value of this unknown resistance, X, Fig. 2, is derived from the formula,

$$X = \frac{AB}{R}$$

where A, B and R are the known resistances. Leads from the terminals for X on the testing box are connected to the winding and to ground, as shown.

In the voltmeter method, Fig. 3, a direct-current supply is used. A reading V is taken on the voltmeter across this supply. Then the voltmeter is connected in series with the machine winding, the supply, and ground, as shown, and a second reading v taken. The resistance of the voltmeter, as marked on its case, is r. The winding resistance R in ohms is then

$$R = \frac{r(V - v)}{v}$$

and in megohms,

$$R = \frac{r(V - v)}{v \times 1{,}000{,}000}$$

After the armature has been dried out, the insulation test will be made on it by applying a high voltage between the winding and ground. A. I. E. E. Standardization Rules call for a testing potential of twice operating voltage plus 1000 volts, for machines operating at less than 2500 volts, to be applied for one minute. This test must neither be prolonged nor made too frequently, nor at a time when the insulation resistance is low, lest the winding be damaged.

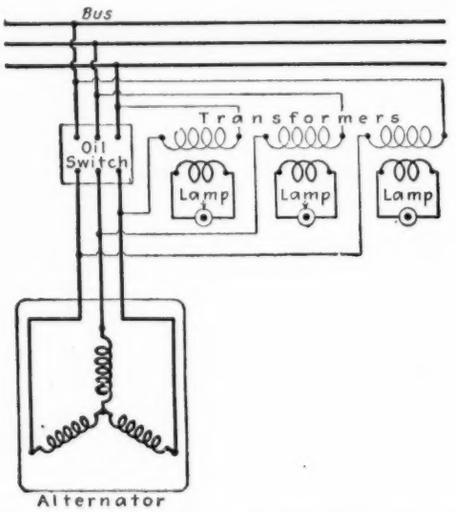


FIG. 5. CONNECTIONS FOR PHASING OUT AN ALTERNATING-CURRENT GENERATOR

The testing potential is obtained through a set of transformers, Fig. 4. One transformer steps down the voltage, which is then fed through a resistance into a second transformer and stepped up to the testing pressure. The voltage is varied as desired through the resistance in the low-tension circuit. Its value at any instant is obtained by multiplying the reading of the voltmeter connected across the low-tension circuit by the ratio of the step-up transformer. An ammeter in series with the resistance shows the current taken by the transformers, and a breakdown of the insulation would be apparent from a sudden increase in the current. Where sufficient potential cannot be obtained from one transformer, two or more units may be used connected in parallel on the low-voltage side with the high-voltage windings connected in series.

The high potential must be applied gradually. The testing transformers must be of sufficient size so that the static capacity of the winding may not overload them and distort their wave form. A distorted alternating-current voltage wave form may have an abnormal peak value. The dielectric stress on the insulation is equal to the maximum value of the testing voltage and should not exceed that of a sinusoidal voltage having an effective value equal to that of the prescribed testing pressure. In general, a testing transformer of 1-kw. capacity will be sufficient for testing voltages up to 2000 volts, and one of 3-kw. for voltages up to 6000 volts. The high voltage should always be reduced before breaking the circuit, to prevent any disturbance that might follow the sudden changing or interrupting of the strong magnetic field. For the same reason the resistance used in the low-tension circuit should be cut in or out without opening the circuit; in this connection an induction regulator is much better than an ordinary current-limiting resistance.

How the Speed Test Is Made

When the breakdown test has been made, the machine is ready for a speed test. After an inspection has insured that its switches are all open, the unit is turned over; when at one-half or three-quarters speed, the field-break switch is closed, with all resistance in on the rheostat. The unit is then brought to speed. Balance adjustments are made if necessary due to vibration. A governor speed-range test is made by operating the governor-motor over its full travel and noting the total change in speed or frequency. Should this range be too high or too low, changes are made in the governor-spring tension to bring it within the desired limits. The speed-range determines the maximum and minimum speeds of the machine under governor control. The emergency trip should be tested by speeding the machine until the trip operates, and adjustments made to cause it to operate at the desired figure, somewhere from 7 to 15 per cent. over speed.

The generator is then brought up to full voltage gradually, and all ammeters watched for abnormal current. Should trouble develop, the field-break switch should be at once opened. Apparent failure of the generator to build up its voltage, or evidence of unsteady voltage, may be caused by a blown potential transformer fuse, poor commutation or loose connection on the exciter or alternator slip rings, poor or open connection in a rheostat or in the instrument wiring.

Phasing Out the Machine

Before the machine may be paralleled with the other units, it must be phased out to insure that its phase rotation is the same as theirs—this apart from merely synchronizing the machine, which is done on only one phase. The simplest of the several methods of phasing out a machine consists in connecting a transformer across the open-circuit of each phase at the oil switch, Fig. 5, and noting whether the lamps connected in the secondaries of these transformers grow bright and dark in unison or in succession. If the phase relations are correct, there will always be the same difference of potential across all the jaws of the switch—whether this potential is zero when the machine and bus are exactly in step, or the sum of the voltages of the machine and bus when they are 180 deg. out of synchronism—therefore, all lamps will grow bright or dark together.

Should there be any difference in the brilliance of the lamps when they are all of the same type and size, one of the phases is crossed and two of the machine leads will have to be interchanged and the test repeated. In this test it must be remembered that, periodically, when

the machine and bus are opposite in phase, the voltage across the jaws of the open switch is the sum of their respective voltages and that this is the voltage on the primary of each transformer. The voltage of the phasing lamps, then, must equal the quotient of twice the bus voltage divided by the ratio of the transformers.

Unless each generator panel has its own phasing lamps and the station has duplicate buses and the new machine may be placed on the bus not in use and phased against the running machines, it is unsafe to phase out between the instrument transformer secondaries of the new machine and the bus, or a running machine's transformer secondaries, because any error in the circuits of the new apparatus would give an incorrect test. When phasing out, and even when synchronizing, the synchronoscope should be checked against the phase lamps to determine that it is at the synchronizing point when the lamps are dark. The phasing-out process is a most important operation. Were the generator to be closed on the running bus while out of phase with it, a short-circuit would be produced.

When the machine has been phased and found correctly connected, it may be parallel with the running machines after the synchronoscope has also been checked against the phasing lamps. If a separate bus is available or if the station can be shut down during the test, it is better to parallel the new machine against one that is carrying no load; as there is less likelihood of damage to the machine in service due to any failure of the new machine. The oil switch should have previously been tried and its action noted in comparison with those of the other machines. After closing the machine on the bus, its field excitation must be adjusted to obviate cross-currents with the other generators. This is accomplished by raising or lowering on the generator rheostat until the armature current is at its minimum.

The new unit should be loaded gradually over a period of a day or two, in order to give all parts a chance to wear in and heat up. During the initial runs frequent adjustments will be necessary on the governor to make it act uniformly with the governors of the units with which it must operate in parallel.

The New Unit Should Be Inspected Frequently

The unit should be shut down frequently during the first few weeks and a complete inspection made to forestall the failure of any part. Bearing temperatures must be closely watched during the first runs. Vibration and rubbing should be looked for, as both cause heating, either from friction or from an unequal magnetic field. The end bells should be removed and the armature inspected to see that no dirt or oil is collecting. Dirt on the windings increases their heating, and oil softens and rots insulation. The screens over the air intake should be frequently cleaned; when they become dirt-clogged, the amount of cooling air is reduced. Dampers should be closed whenever the unit is shut down and opened gradually when it is started, to prevent condensation or the windings from the cold air. The air entering the machine when it is standing should never be of lower temperature than the air of the room.

After the unit has carried full load, its most efficient loading points should be determined, if possible, by plotting a curve of its steam consumption at various loads up to and above full load. Plant efficiency will depend on the efficiency of the individual units, so that the economical loading of each machine is a factor worthy of study.

Correcting Power Factor With Idle Transmission Lines

By L. W. Wyss

The scheme described in this article is not new to operators of most power-transmission systems employing long, high-tension lines; namely, to use idle transmission lines as condensers to raise the power factor of the system, even though they are not used for transmitting power. In a generating system consisting of a 1200-kv.-a. hydro-electric station which delivered power over a 90-mile 66,000-volt duplicate transmission line to a combined substation and steam plant, four towers were blown down during a severe windstorm. It would require from 24 to 48 hours to erect some kind of a temporary line to bridge the gap, because of the rough country and bad weather conditions.

The steam plant was now required to handle the full load, which averaged about 8500 kw. except during the light-load periods. The average power factor of the system was about 0.75 lagging, making the kilovolt-ampere load equal to $8500 \div 0.75 = 11{,}330$, but in the steam station the total capacity of the plant was only 9250; therefore the generators would be seriously overloaded. There were two ways of reducing the load on the station—to cut off some of the power users' circuits, or to improve the power factor, the latter being given preference. A lineman was ordered to cut the 66,000-volt line at the most convenient place on the steam-plant side of the break, after which the line was energized. When the line was used as a condenser, it furnished 2830 reactive kilovolt-amperes at a leading power factor. This reduced the load on the station to 9650 kv.-a. and raised the power factor to 0.88—a load that the generators could handle without being overloaded.

In another case on a small transmission system where the original installation consisted of a steam plant with two engine-driven units of 80- and 210-kw. capacity respectively and a 500-kw. steam-turbine unit connected over a 12-mile 11,000-volt line, with a 640-kw. hydro-electric plant, the load had increased to a point where it was decided to build another hydro-electric station and tie it on the system through a 38-mile single-circuit 40,000-volt line. However, before the new plant was finished, the other stations, became very heavily overloaded, mainly because they delivered load at about 0.72 power factor. The average load during the heavy-load period was 1275 kw. at 0.72 power factor, or 1770 kv.-a. The 40,000-volt line was completed and the transformers, switches and lightning arresters were installed at the steam plant. It would be a number of weeks before the new plant would be ready to run, therefore it was decided to use the line for power-factor correction. The 480 reactive leading kilovolt-amperes obtained from the line raised the power factor of the system from 0.72 to 0.86 and consequently cut down the kilovolt-ampere load of the generators from 1770, before the line was used as a condenser, to 1480 kv.-a. after the scheme was put in effect. In addition to this the 40,000-volt line and equipment received a good tryout before being put into regular service.

Hagan Combustion-Control Regulator

The amount of steam generated by a boiler determines the quantity of fuel and air that must be supplied. It is therefore apparent that the fireman is feeding fuel and air to the boiler furnace in accordance with the flow of steam from the boiler. Working on this basis, the Hagan Corporation, Pittsburgh, Penn., has developed a

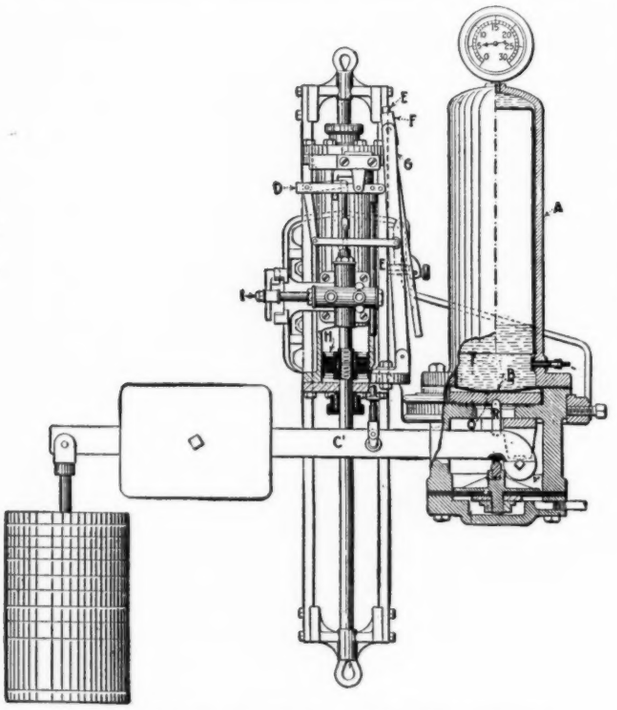


FIG. 1. SHOWING DETAILS OF THE REGULATOR

system of combustion control that regulates the fuel and air supply in accordance with the flow of steam.

The apparatus is sensitive to small variations in pressure, and it is therefore possible to operate the regulating mechanism on the small differential pressure due to flow, which may be secured by inserting a standard plate orifice in the steam line.

In regulating the damper and stoker two distinct devices are used, the damper being controlled by the regulator, Fig. 1, which is fitted with an adjustable compensator, and a roto reciprocating valve, Fig. 2, for controlling the stoker speed. Fig. 3 shows how these two appliances are arranged for use with a natural-draft boiler and how the movement of the regulator is communicated to the roto valve.

By means of an auxiliary air cushion and a secondary diaphragm *B*, Fig. 1, the regulating mechanism is made to take an incremental movement for variations in rate of flow or steam pressure between the two extremes for which the apparatus is adjusted, and there is no tendency to regulate from one extreme to the other except in case of a sudden change in demand from one extreme to the other.

A plant having a steady load can obviously have closer regulation than one where there are great fluctuations in steam demand, and the sensitiveness of the regulating apparatus must therefore be capable of adjustment. This is secured in two ways: First, by varying the pressure in the air chamber *A*, and, second, by changing the angularity of the adjustable compensator. By means of these adjustments it is possible to secure a full stroke of the regulator with a differential pressure as small as 1 oz. or as great as 15 lb.

As the movement of the weight arm is transmitted to the rocking frame which carries the pilot valve there will be a definite movement of the pilot valve for each increase or decrease in pressure, and this movement, combined with the action of the compensating device, makes it possible to adjust the regulator so that the piston will move incrementally with variations in applied pressure under the diaphragm, and these increments can be varied in extent to suit local conditions.

With a movement of the diaphragm sufficient to open the pilot valve the movement of the plunger will continue until the pilot is closed by the compensating mechanism. The compensating bar can be set parallel with the direction of movement of the plunger, and there will be no compensating action, a minute opening of the pilot valve producing a full stroke of the regulator. By increasing the angularity of the compensator the length of stroke secured for each movement of the pilot valve will be reduced.

The operation of the adjustable compensator is as follows: The weighted lever *C* of the regulator moves

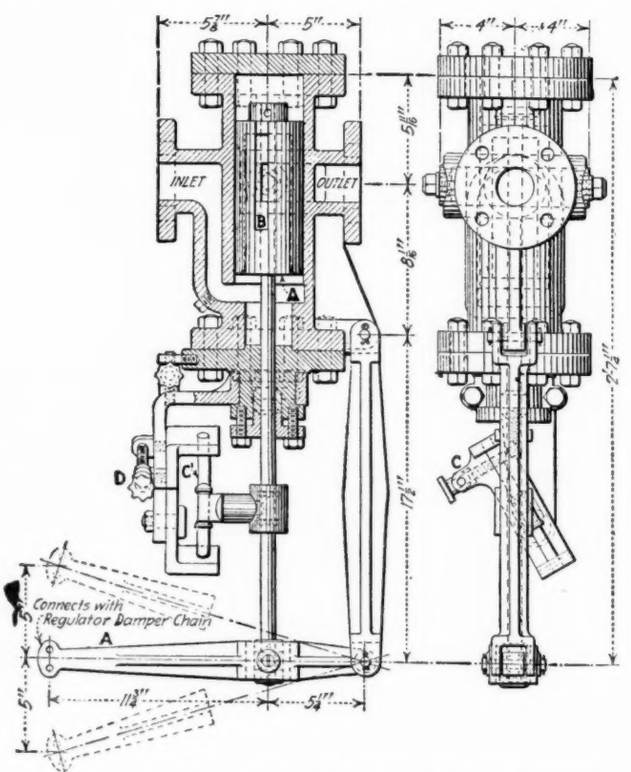


FIG. 2. DETAILS OF THE ROTO RECIPROCATING VALVE

up with a decrease in flow or an increase in pressure. The movement of this lever is transmitted through an adjustable rod to the rocking frame *D*. A bell crank is connected to the pilot valve stem by means of a link and to the compensator lever *E* by means of a second link.

The guide bar carries a bracket on which is pivotally mounted the adjustable compensating bar *E*. By means of the adjusting screw the angularity of the adjusting bar *E* is changed. At the top of the compensating lever *G* is a guide shoe *F*, in which the bar *E* slides. When the regulator is in operation a downward movement of the crosshead *R* and compensating bar *E*, sliding through the shoe *F*, will move the compensating lever *G* to the

left, causing the pilot-valve stem to move down until the valve is closed, stopping the movement of the piston. The distance the piston *H* will travel to shut the pilot valve after it has opened, or vice versa, depends upon the angle given to the compensating bar *E*.

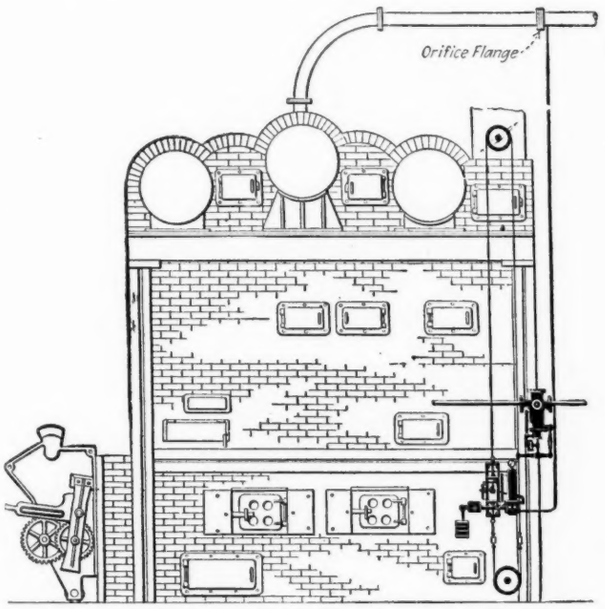


FIG. 3. CONTROL APPARATUS AS IT IS CONNECTED TO A BOILER

When blowing tubes the boiler dampers should be kept wide open, irrespective of the steam demand on the boiler or the steam pressure. A bypass valve *I* is therefore provided as a part of the mechanism, by which the regulator may be thrown in its wide-open position and kept there independently of any variations of flow or pressure. This bypass valve can be thrown in a reverse position and the regulator moved to a closed position and held there. In the mid-position of this valve the regulator is operative from variations in flow and pressure. In order that the full advantages of such a regulator may be realized, it is necessary to incorporate into the system of regulation a regulating valve, by means of which the speed of stokers and draft fans can be controlled with a degree of accuracy equal to that which the the regulator itself responds to variations of flow and pressure. To accomplish this, a roto-reciprocating valve is used (see Fig. 2). This valve is of the piston type, the piston having a combined reciprocating and rotating motion. The reciprocating motion is imparted to the valve by the regulator, and the rotating motion is adjustable from the outside of the valve to suit the existing conditions.

The minimum opening of the valve that will be required to meet any given condition is determined, and the valve is set to give this desired minimum. It is then possible to start from this minimum, and by using the full stroke of the valve at all times, adjusted for any desired rate of increase and any desired maximum. These adjustments are made from outside

The movement of the valve is controlled by the travel of the regulator piston in moving the damper chain. The roto-valve cylinder is cast with a port that extends from the inlet to a chamber below the hollow piston *A*, Fig. 2. This piston is made with slots *B* which are open to the exhaust ports cast in the cylinder and communicate with the outlet opening.

The regulation of the volume of steam is brought about by the reciprocating movement of the valve, which also has a rotating movement. This is accomplished by means of an angular adjusting head. The valve piston is first set so that the least desired amount of steam is passed through the valve slots to the outlet, say, sufficient to operate one stoker engine or turbine at minimum speed. With the head set parallel with the valve piston the valve opening remains the same, regardless of the position taken in a reciprocating movement. If a second unit is put on the line it is only necessary to adjust the angle of the adjusting-head rod *C* to a degree that will supply the steam. This is done by the screw *D*. If more engines are put on the line, the angle of the head is increased

When the piston is down to the zero point, any adjustment of the adjusting head does not change the port opening of the valve, but as soon as the piston begins to move, the crosshead sliding on the angular adjusting head rod *C* produces a rotating movement to the valve and gradually opens the port, owing to its rotating motion as the piston moves upward. If sufficient angularity is given to the adjusting head, the valve will move in a rotating direction from just a crack to wide open while it is making its stroke. As the piston

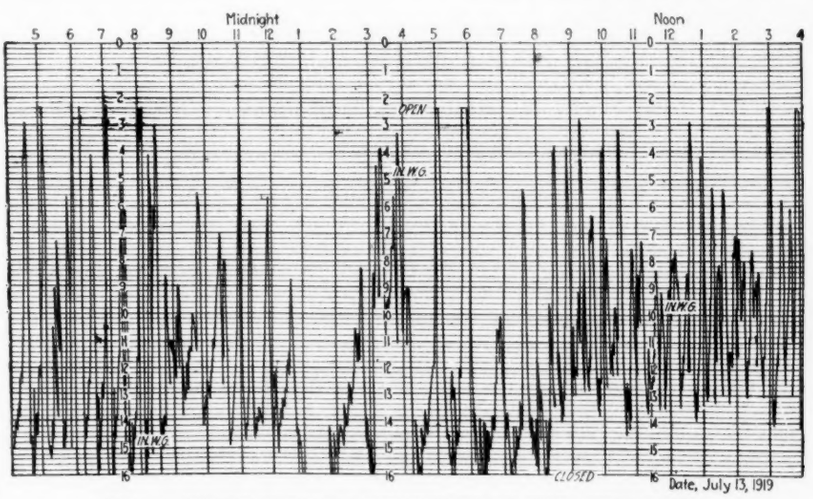


FIG. 4. CHART SHOWING MOVEMENT OF THE ROTO VALVE

B is moved up or down by opening or closing of the damper, the roto valve acts in unison with the regulator and closes off the steam to the stoker and fan engine with the closing of the damper, and admits steam with the opening of the damper.

As a matter of fact, the damper or roto valve seldom closes during ordinary running conditions, but is operating in some mid-position between open and closed, the position depending on the load. This is shown by the chart, Fig. 4, taken with a Hagan regulator control. From 8:15 p.m. until 5 a.m. the regulator did not reach the wide-open position, and from 8:15 a.m. to 3 p.m. the regulator never reached either extreme position.

Refrigerating-Plant Economy Simplified

By VICTOR J. AZBE

EFFICIENT operation of a refrigerating power plant depends on a number of factors, each of which exerts an influence on general economy. For example, there is excess air, CO_2 in the flue gases, the flue-gas temperature, the carbon in the ash, the feed-water temperature, the steam pressure, the back pressure or vacuum at the engines or steam pumps, the ammonia condenser pressure, the ammonia suction pressure, the temperature of the water to be frozen, the temperature of the liquid ammonia, the heat lost through uncovered steam and ammonia pipes, the auxiliary power required per ton of ice, the cost of ammonia per ton of ice, etc.

It is impossible for an engineer to state with a great degree of accuracy what influence a certain change in operating conditions will have except by consulting text-books or referring to tabular data. Great accuracy under practical conditions is seldom required, and to be able to tell offhand from memory with an approximate degree of exactness what, for example, the increase of ammonia suction pressure by one pound means from the economy standpoint is of the greatest value and is what makes good engineers, since it teaches them to appreciate small items.

Approximate Data Close Enough for Practical Purposes

In the following paragraphs approximate data in simple form are given. Since these factors vary, they are accurate at a certain point and off at others, but generally speaking, the figures given are close enough for all practical purposes.

In the boiler room the percentage of CO_2 in the flue gases is used to judge the loss due to excess air. This factor is modified by the temperature of the flue gases. With a flue-gas temperature of 550 deg. F., each one per cent. increase in CO_2 between 7 and 9 per cent. represents a saving of 2.5 per cent. in fuel; between 9 and 11 per cent. the saving due to an increase of 1 per cent. in CO_2 is 2 per cent. in fuel economy; and between 11 and 14 per cent. CO_2 the saving in fuel per unit increase in CO_2 is 1 per cent.

With the same flue-gas temperature, doubling the CO_2 percentage will reduce the fuel loss due to excess air by one-half. For example, with 6 per cent. CO_2 and a flue-gas temperature of 600 deg. F., the loss up the stack is 34 per cent. By increasing the CO_2 to 12 per cent., with the same flue-gas temperature, the loss will be 17 per cent. Actually, the gain is greater because increasing the CO_2 reduces the flue-gas temperature when the boiler load remains the same.

Every 25 deg. F. reduction of flue-gas temperature when the CO_2 percentage is 12, will effect a saving of 1 per cent. in the fuel bill and when the CO_2 is 6 per cent., the saving is twice as great, or 2 per cent.

Loss from Uncovered Steam Pipes

With reference to uncovered steam pipes it can be assumed that every square foot will cause a loss of one-half ton of coal per year. Therefore with 100 sq. ft. of uncovered pipe and the plant operating 365 days a year, the loss will be 50 tons of coal, which at the usual cost of coal, represents quite a substantial sum.

Every 10 deg. F. increase in feed-water temperature means a saving of 1 per cent. in coal provided the water temperature is raised by otherwise waste heat.

Taking the steam engine, generally speaking the higher the steam pressure and the lower the back pressure the greater the economy. This statement of course has its limitations, but they do not enter into ordinary everyday operation. By raising the steam pressure from 75 to 100 lb. gage, the steam consumption will be reduced 7.5 per cent. By increasing it another 25 lb. there will be a further reduction of 4 per cent. and by raising the pressure still higher there will be an additional gain but the saving will become proportionately less as the pressure increases.

Back Pressure More Important than Initial Steam Pressure

A more important factor than initial steam pressure is the back pressure. Every pound reduction in the back pressure above the atmospheric line means a saving of 1.5 to 2 per cent., depending on the type of the unit. Below the atmospheric line it can be assumed that between 0 and 10 in. of vacuum, the gain for each inch is 2 per cent.; between 10 and 20 in., the gain for each inch is about 0.8 per cent., and from 20 in. on, even less. This holds true with reciprocating engines only, and even with them it will depend upon a number of factors such as cylinder ratio, for example. With turbines the gain instead of decreasing will increase with each inch of improvement in vacuum.

With the ammonia compressor, low condenser pressures and high suction pressures count. This is exemplified by the exaggeration that if the condenser pressure could be brought down and the suction pressure raised to such a point that both would be alike, then no power would be required to operate the compressor, except that necessary to overcome friction. This, of course, is impossible, but there are many engineers who do not realize the importance of bringing together these two pressures as closely as operating conditions will permit.

Every 5 lb. reduction in condenser pressure means a saving of 2 per cent. in compressor power required, so that a reduction in condenser pressure of 20 lb., which very often is possible, would meam the saving of 8 per cent. of the steam used by the compressor engine.

Increase of Suction Pressure More Important Than Equal Reduction of Condenser Pressure

Increase of suction pressure is more important than an equal reduction of condenser pressure. Every pound of increase in suction pressure at the compressor will reduce by 2 per cent. the compressor power required per ton of refrigeration. In other words, an increase of 4 lb. in suction pressure is equal to 20 lb. reduction in condenser pressure.

These are average figures, but can be used to good advantage. As the range of suction pressure increases, the saving per pound becomes less, and in the case of condenser pressure a reduction from 240 to 230 lb. will not mean so great a saving as from 160 to 150 lb. Of course, the reduction at the higher pressure is easier to get and is obtained with less expenditure for auxiliary power, because the cost of pumping cooling water must be taken into consideration.

In reducing condenser pressures it should be borne in mind that improper distribution of water over the cooling tower may eventually cause a loss of 5 per cent. of the fuel. Good towers will cool water for the ammonia condenser down to 3 to 5 deg. F. of the wet bulb. Very often, when the condenser is blamed for poor performance, the actual reason is improper or improperly operated cooling towers.

Another important factor is the temperature of the liquid at the expansion valve before injection into the evaporating system. The liquid temperature should be within 3 deg. F. of the coldest water available in the plant. The saving in refrigeration is 2 per cent. for each reduction of 5 deg. F. in temperature.

The temperature of distilled or raw water also should be down to within 3 deg. F. of the coldest available circulating water before it is allowed to enter into the forecooler. The saving here is 1 per cent. for every 2 deg. F. reduction in temperature.

Another item worth remembering is that the ice plants should be so designed that the auxiliary power required will not exceed ½ hp. per ton of ice manufactured. Often as much as 1 hp. is used and developed by the most uneconomical means.

With few exceptions ice plants are uneconomical. Simple plants, instead of producing 5 tons of ice per ton of 10,000 B.t.u. fuel, produce 1½ to 3 tons on the average per year, and the reason is that the small savings possible here and there throughout the plant are disregarded.

Handling Superheaters During the Starting-up Period

BY F. C. TORRANCE

The question of flooding superheaters during the starting-up period of putting the boiler "on the line" has had a great deal of discussion. At the beginning the theory was that the superheater tubes should be filled with water while the boiler was being started up in order to prevent burning out the tubes. This theory would probably still hold true if it were customary to put a blazing hot fire under a cold boiler and rush it onto the line. This, fortunately, is not the case. The practice in large stations has gradually been to draw away from flooding superheaters until now some stations do not even supply flooding pipes for the superheaters. In at least one instance it was proved that flooding did damage and not good. The superheater in question was of the double-loop type; that is, the steam was admitted to one header and passed through one set of tubes to a smaller header, which was attached to a similar header by short nipples. Thence it returned to the outlet header through a second set of tubes. The practice was at the start to flood the superheater. Trouble occurred after a time with leaks around the nipples connecting the small headers. These leaks appeared around the nipples where they were expanded into the upper header. One of the theories advanced for these leaks was that all water could not be drained out of the upper header and that it lay around the nipples in the upper box, thus causing unequal expansion. From then on the superheaters were not flooded in that station.

There are superheaters on the market that have, to the writer's knowledge, never been flooded. These are of the type that have cast-iron shroud rings around the tubes. The rings, of course, protect the tubes during the starting-up period.

Superheaters that are not flooded should be equipped with a drain so that they may always be blown out. On starting a boiler up after it has been cold, the drain should be opened. This will produce a tendency for the first vapor that is given off from the water in the boiler to pass through the superheater and prevent any chance of overheating the tubes. It will also blow out any water that may have condensed in the tubes. On bringing a boiler onto the line after it has been banked, it is a good thing to open the drain valves from the superheater to be sure that there is no water in the tubes.

If the superheater is not flooded, the danger of cutting the boiler in on the line without first draining the superheater is removed. This is a point that is of course up to the operating man, and in this way the human equation is removed. Another point in favor of not flooding the superheaters is the amount of pipe and valves that are saved. This is a relatively small item, but should be considered.

Another thing that should be carefully watched in all boiler plants is the setting of the superheater safety valves. These should always be set to pop first. In this case, if the station loses its load for any reason, there will always be a flow of steam through the superheater. There have been instances when no damage resulted when the safety valves on the drum popped first. The writer saw a very clear case of this when a calorimeter had been placed on the line from the drum to the superheater in order to determine the amount of moisture being carried over from the drum. This calorimeter was equipped with a recording thermometer. It happened that the load on the station was dropped at a time when the boiler in question was working at approximately 300 per cent. of rating. This caused the safety valves to pop, and the drum valves let go, first taking care of the boiler output so that there was a comparatively small amount of steam passing through the superheater, as was proved by the fact that the temperature in the line from the drum to the superheater rose to such an extent that the recording thermometer on the calorimeter was damaged. This was caused by superheated steam backing into the drum from the superheater. While there was a small amount of steam passing through the superheater to take care of the station auxiliaries at this time, by far the largest amount was being discharged through the safety valves on the drum, and yet no damage resulted to the superheater. While this is not a good practice, it is mentioned here to show that superheated tubes will not as a rule be damaged in extreme cases as long as a small amount of steam is passing through them.

In summing up, it seems that superheaters can safely be used without flooding. All precautions should be taken, however, to insure safety. Drain lines should be installed and used when starting up a cold boiler or when bringing a boiler onto the line from a banked condition. The safety valves on the superheaters should be set so that they will pop before the valves on the drum. If these precautions are taken there can be very little if any damage done to the ordinary installation of superheaters.

Heating System Vacuum*

By D. N. CROSTHWAIT, Jr.

This article deals with heating systems in which the steam is circulated at atmospheric and greater pressures. The argument shows that a high vacuum in the return piping of a heating system requires a larger amount of power to operate the vacuum pump.

WHAT degree of vacuum should be carried in the return piping of a vacuum heating system is something on which many engineers operating such systems seem to disagree. From 8 to 10 in. is the degree of vacuum most ordinarily maintained in practice, while as high as 20 in. and as low as 2 in. are often found.

Upon consideration it will be remembered that with the ordinary vacuum heating system the vacuum is generally maintained in the return line only, while the steam pressures carried may vary anywhere between 1 and 10 lb. gage, although, at times the steam is circulated at less than atmospheric pressure. Such cases, however, are comparatively rare, and for this reason the following will deal more particularly with the case where the steam is circulated at pressures varying from atmospheric to greater ones.

It is often noticed that no difficulty is experienced in obtaining a moderately high degree of vacuum in the return piping of a vacuum heating system when the steam pressure carried on the radiators and in the steam piping is low, and that an increase in steam pressure results in a reduction of the vacuum. In discussing the reason for this a number of factors must be taken into consideration.

A trap of some sort is generally used on each radiator in vacuum steam-heating practice. The purpose of this trap is to free the radiator from air and water while retaining the steam. If the traps did not prevent the steam from the radiators entering the returns, it would not be possible to produce a vacuum in the return piping without the use of a condenser of some kind. In former years the use of condensing water in the returns of vacuum steamheating systems was looked upon with favor, but its use is becoming less frequent, because of the many disadvantages connected therewith and the obviation of its use by the commercially successful thermostatic radiator trap. With such a radiator trap of proper design the outlet temperature, or the temperature of the water released by the trap, will bear a definite relationship to the steam pressure in the radiator.

It is a known fact that an increase in steam pressure is accompanied by a rise in the steam temperature. The temperature of the steam in the radiator will vary with the steam pressure, consequently an increase in the pressure of the steam in the radiator will result in an increase in its temperature. Then, if the outlet temperature of the trap bears a definite relation to the steam temperature or pressure, the outlet temperature will increase in the same proportion as the steam temperature increases. Or, in other words, the temperature of the water entering the return piping will increase as the pressure increases.

For example, in Fig. 1 two curves are plotted. One is the outlet temperature obtained in some radiator tests plotted against the steam pressure existing at which the outlet temperature was obtained; the other is the temperature of the steam entering the radiator at these same pressures. Each point on the curve represents the average temperature obtained at the average pressure maintained for a given period in a series of tests made on a thermostatic trap. These curves show clearly the variation of temperature with pressure variation in a radiator under the given conditions.

Since the boiling temperature of water depends upon the pressure upon it, the reduction of the pressure upon the water means the lowering of its boiling point, the difference in the heat of the liquid between the two boiling points serving to vaporize a part of the liquid. As the vacuum in the return line becomes greater, the

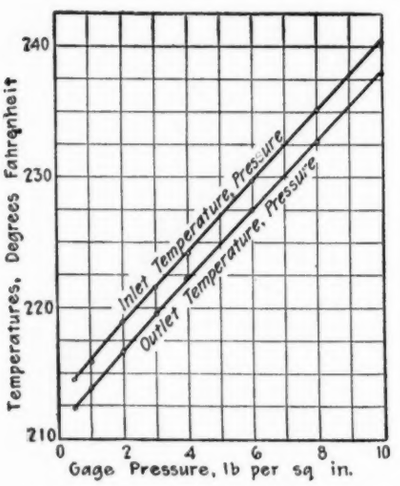


FIG. 1. CURVES OF INLET AND OUTLET PRESSURE

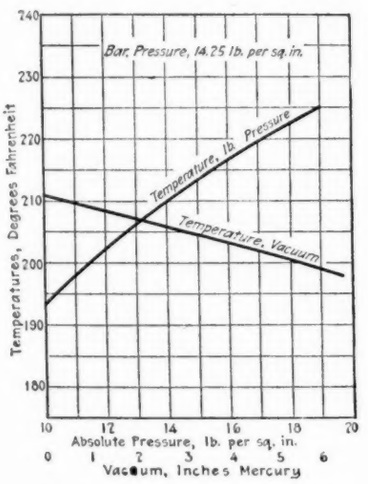


FIG. 2. TEMPERATURE PLATTED AGAINST VACUUM

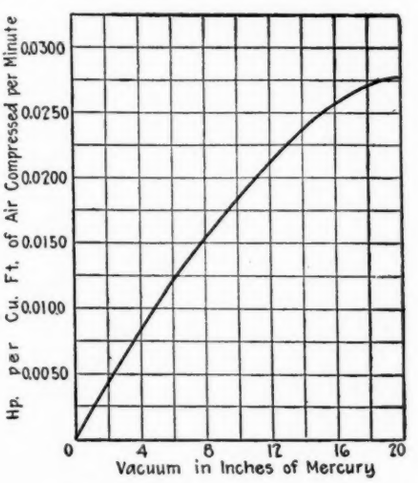


FIG. 3. INCREASE OF H.P. CONSUMPTION PE RINCREASE OF

*Copyright 1919, D. N. Crosthwait, Jr.

temperature at which the water contained therein will boil becomes less. With an atmospheric pressure of 29.1 in. of mercury and a vacuum of 5.6 in. prevailing in the return line, the water will boil at a temperature of about 200 deg. F., provided it does not lose enough heat to prevent it. Similarly, with the atmospheric pressure remaining the same, an increase of the vacuum to 10 in. would lower the boiling point to 190 deg. approximately. Thus it is evident that if water at a temperature higher than that corresponding to the pressure is released into the return line, it has a tendency to increase the pressure therein to that correcsponding to its temperature. Hence, there is a tendency for the vacuum in the return line to decrease as the pressure increases and a decrease in the vacuum under such circumstances is no sign that there is steam leakage into the return piping.

For example, if water at 200 deg. F. is discharged into a return line in which a vacuum of 10 in. of mercury exists (atmospheric pressure being the same as in the foregoing), the heat of the liquid will be 167.94 B.t.u. per lb. Under the same atmospheric pressure the heat of the liquid for a 10 in. vacuum is 157.91 B.t.u. per lb. which gives an excess of 10.03 B.t.u. per lb., which will serve to vaporize a part of the water. The vacuum existing in the return pipe remaining the same, an increase in the temperature of the water entering it will result in an increase in the heat of the liquid available for reëvaporation. Also, with a given temperature of the water entering the return line, an increase in the vacuum carried will result in an increase in the heat of the liquid available for vaporization. So, if conditions are not such that the water entering the return piping will have the excess heat dissipated, the loss of a certain amount of vacuum will result. This is clearly shown by Fig. 2.

Aside from the variation of the steam pressure, it should be noted that there are a number of factors that affect the vacuum obtainable in the return piping of a vacuum heating system. Among them are air leakage, the facilities for dissipating heat and the capacity and condition of the vacuum pump. The effect of these will vary with every installation. Generally speaking, the degree of vacuum obtainable will increase as the ability to dissipate the excess heat increases, other conditions being equal. Thus with returns uncovered a greater degree of vacuum is obtainable than where they are covered, or where the returns run through a cool basement as against a hot basement. In either case the vacuum obtainable will decrease with the increase of the steam pressure.

The reason for maintaining a vacuum in the return piping of a heating system is to maintain complete circulation of the steam throughout all of the heating units at the steam pressure for which the system of heating was designed. This is a low pressure, generally not over 2 lb. gage, and the vacuum is maintained so as to provide for the circulation of the steam throughout the system by maintaining a sufficient differential to permit the removal of water and air from the radiators.

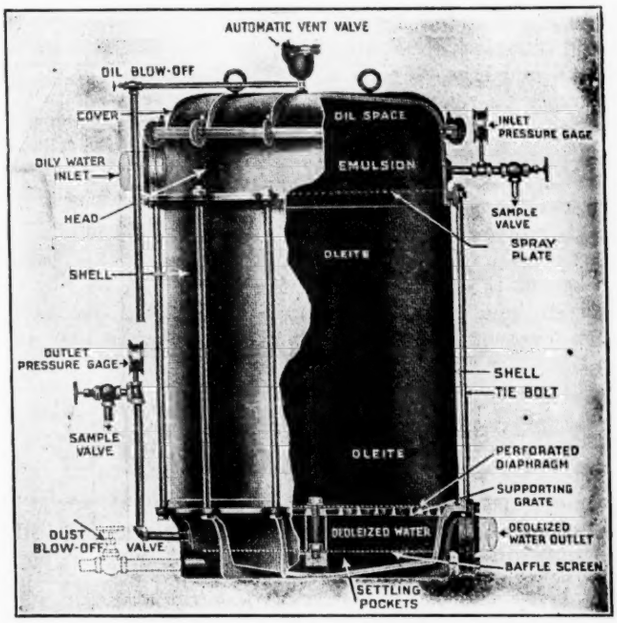
The power consumption of a vacuum pump increases as the vacuum increases, provided the head it discharges against remains constant. This is clearly shown by Fig. 3.[1]

[1]The curve in Fig. 3 is plotted from data given in Vol. II, of Harding and Willard's "The Mechanical Equipment of Buildings."

Since the maintenance of a high vacuum in the return piping of a heating system requires a large amount of power to operate the vacuum pump, a reduction in the temperature of the water handled by the vacuum pump—which means a lowering of the temperature of the water used for boiler-feed purposes or discharged by the vacuum pump to the feed-water heater—and moreover, since increasing the degree of vacuum beyond a certain point has little effect on the pressure of the steam in the heating units, it is evident that the desirable vacuum for most cases is the lowest at which complete circulation of the steam can be maintained with the given steam pressure.

Oily Condensate Deoleizer

The elimination of cylinder oil from the emulsified return from a heating system or the condensate from



SEMISECTIONAL VIEW THROUGH THE DEOLEIZER

a surface condenser is a difficult problem, but is desired by all engineers. If oily returns are freed from the emusified oil, a saving in feed water by using the returns instead of wasting them will be made, a saving in coal by saving the heat units in the return will be possible, and a boiler free of oil will be assured.

To do this a device known as the Deoleizer has been developed by the Oleite Corporation, 95 William St., New York City. This apparatus does not depend upon the chemical straining out of oil as it passes through a filtering material, etc., but upon the absorption property of a mineral substance of cellular structure called "oleite." The type of apparatus described herewith consists essentially of four principal parts—the base, the shell, the head and the cover. It is divided into four spaces by perforated diaphragms. The oily returns of condensate enter near the top through a flanged nozzle, and the deoleized water leaves near the bottom through a similar nozzle.

If the returns contain any free oil upon entering the head, it rises and accumulates in the oil space in the cover, out of the way of currents. The free oil can be drawn off as required, at the oil flow, and

used again if desired. The oleite, with an intermediate cloth screen, rests on a diaphragm of noncorrodible metal perforated with fine holes very close together. It is supported by a cast-iron grating filled with large circular holes to allow a free exit of the purified water. This grating is necessary in order to support the weight of the oleite. The diaphragm rests on rounded knobs projecting above the grating. Any fine particles of oleite that may accidentally pass the perforated diaphragm sink through the dead-water space in the base and drop through a closely perforated baffle-screen in the settling pocket below, where they are out of the current and can be blown off. The cover is packed on the head with a rubber tubular packing and is bolted in place.

The oleite has an affinity for oil and its derivatives, and as the water passes through the bed of oleite the oil is absorbed by it and the water passes to the bottom in a refined state. Low-pressure gages and sample valves are fitted to the head and base respectively. The difference in reading on the gage indicates when the oleite is becoming unduly clogged. This will happen at intervals of anywhere from one month upward, depending upon the amount and character of the oil. To clean, remove the cover and spray the plate, take out the oleite down to the cloth screen, and replace with new oleite. The saturated oleite can be made ready for use again by burning the oil of it, which makes it as good as new.

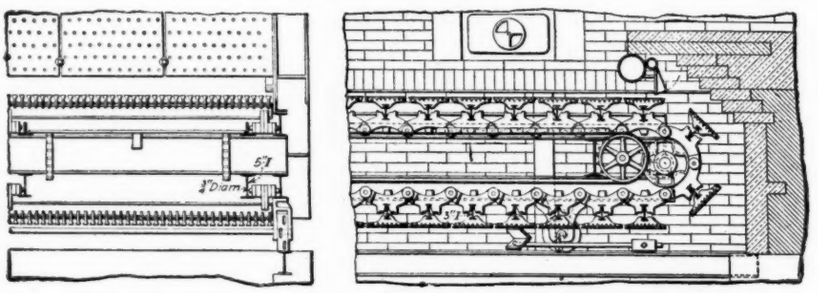
Shutting off Excess Air Through Traveling Grate

Motorcycles are turned out in large numbers by the Excelsior Motor Mfg. & Supply Co., Chicago. In the manufacture of these machines there is need of considerable electrical energy for power and lighting and steam for process work. These services are rendered by a private plant consisting of two 480-hp. water-tube boilers equipped with traveling grate stokers. Steam is supplied at 150 lb. pressure. There is a conveyor system to handle the coal, overhead bunkers and automatic scales to weigh it. A steam jet vacuum system disposes of the ash. In the engine room there are two generating units consisting of 220-volt direct-current machines driven directly by Corliss engines. One unit is rated at 300 kw. and the other has one-half this capacity.

At the present time the load averages, 400 kw., for 11 hr. per day and in addition steam is supplied for process work. At one time it required the two boilers to handle this load and the efficiency was below normal. With Franklyn County "Spiralized" coal it was necessary to carry an 8-in. fuel bed the full length of the grate, and at periods of lighter load the fire could not be shortened without excessive loss.

Excess air passing through the grate and around the rear of the stoker was the cause of the low efficiency of combustion. Repeated tests with an orsat connected to the uptake showed that it was impossible to exceed 6 per cent. CO_2. To eliminate much of this excess air was the problem and the accompanying illustration shows how it was done.

To prevent excess air passing through the grate, particularly toward the rear portion, the engineer designed steel curtains, one on either side of the rollers and supporting structure at the center of the stoker, that were adjustable and could be set to seal off the dead portion of the fire at the rear. Each curtain consisted of 14 flat lengths of steel 4 in. wide, $\frac{3}{16}$ in. thick and 4 ft. 3 in. long, laid crosswise of the furnace between the upper and lower runs of the stoker, on ordinary link chain at either end, with lugs on each link to which the bars were riveted. The chains run over sprockets at either end of the stoker, and at the front the shaft runs through the four sprockets, with a ratchet handle at the end so that adjustment of the two curtains may be made simultaneously. The curtains fit snugly and make a good seal. Lengthwise of the stoker the curtains measure 14 × 4 = 56 in. They may be run forward or back over the rear sprockets, as desired, so that the fronts of the curtains may be set at any point of the grate, depending upon the length of the fire.



SHOWING AIR CURTAIN AND AIR BAFFLE APPLIED TO STOKER

To prevent air leakage around the rear of the stoker a series of cast-iron baffle hangers, properly ribbed to prevent warping, were mounted behind the waterback on a piece of piping with solid shafting inserted to make it rigid. Each hanger is about 5 in. wide and as the baffle extends all the way across the stoker, dragging on the dead ash, a good seal is effected.

With the two baffles in place a great improvement in results was noticeable. The best length of fire to meet the requirements of load and atmospheric conditions could be carried. With the same fuel and a load greater than before a fuel bed 4 in. thick proved sufficient. The CO_2 jumped to 14 per cent. and was maintained continuously within the range of 12 to 14 per cent. More rapid steaming is particularly noticeable. A big factor in the saving is that one boiler now carries the load.

At the present writing the daily coal consumption averages 9 tons and to carry the peak load in winter rarely exceeds 12 tons. Formerly with a smaller load, the daily coal consumption ranged from 15 to 20 tons, the higher figures indicating the winter peak load. A conservative estimate indicates a saving exceeding 5 tons of coal per day.

An electric power company is not liable for death of a boy who, by climbing a tree, came in contact with a wire carrying a dangerous voltage, where the wire was thirty feet above the ground, unless it be determined that the wire was so situated that an ordinarily prudent person would have foreseen such an accident. (California Supreme Court, Minter vs. San Diego Consolidated Gas and Electric Co., 182 Pacific Reporter, 748.)

The Electrical Study Course—Power in Polyphase Systems

Comparison is made between the voltage and current per phase in the line conductors and that for the load in both two- and three-phase systems, and then it is shown how to calculate the power in polyphase systems.

IN ORDER to understand the relations between voltage, current and power in two- and three-phase systems, it is necessary first to consider the relations between the currents and voltages of the load and those of the lines.

In Fig. 1 is represented a two-phase four-wire system. The current in the lines A and B, as indicated by the ammeter A_1, is obviously the same as that flowing through the load L_1, and similarly that through L_2 is the same as the current indicated by ammeter A_2. If the loads are the same—that is, if the system is balanced—ammeters A_1 and A_2 will read alike. Thus, if L_1 takes 100 amperes, L_2 will take 100 amperes, and the readings of A_1 and A_2 will be 100 amperes each. If the line voltage as indicated by voltmeters V_1 and V_2 is 500 volts, the voltage of the loads as indicated by V_3 and V_4 will also be 500 volts.

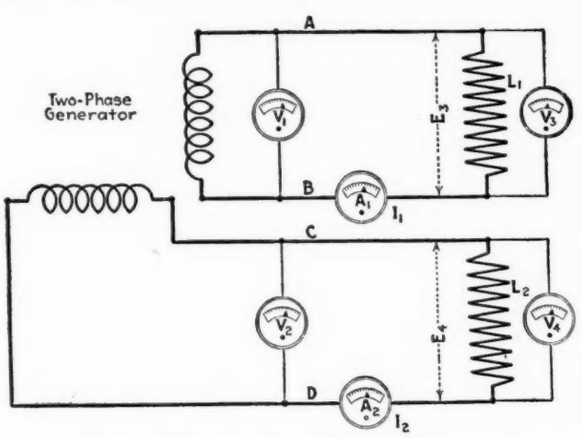


FIG. 1. FOUR-WIRE TWO-PHASE CIRCUIT

If the loads of Fig. 1 are connected to the same system changed over to three-wire transmission, we have the arrangement shown in Fig. 2. In this case ammeters A_1 and A_2 again read the currents through the loads L_1 and L_2—namely, 100 amperes each—but A_3 reads the resultant of these currents, which for alternating currents 90 deg. out of phase will be equal to $100 \times 1.414 = 141.4$ amperes—the reading of ammeter A_3. The voltmeters V_3 and V_4 will read the same as V_1 and V_2—namely, 500 volts—and V_6 will read the same as V_5, whose reading will be $500 \times 1.414 = 707$ volts.

In Fig. 3 we have three equal loads connected delta to a three-phase system. Assume that the loads take 100 amperes each; then ammeters A_4, A_5 and A_6 will each read 100 amperes. The current in line A will be the resultant of that in L_1 and L_2, which for currents 120 deg apart will be $100 \times 1.73 = 173$ amperes. The currents in lines B and C are the resultants of L_2 and L_3, and of L_1 and L_3 respectively, so that each of them also is equal to 173 amperes. Hence ammeters A_1, A_2 and A_3 will all read the same. The voltages across L_1, L_2 and L_3 are the same as those across lines AC, AB and BC. Hence, if voltmeters V_1, V_2 and V_3 read 500 volts, V_4, V_5 and V_6 will likewise read 500 volts.

In Fig. 4 we have the three loads of Fig. 3 connected "Y" instead of delta. In this case the currents in lines A, B and C are the same in value as those through loads L_1, L_2 and L_3 respectively, and therefore ammeters A_1, A_2 and A_3 will read the same as A_4, A_5 and A_6; namely, 100 amperes. If the voltage registered by voltmeters V_4, V_5 and V_6 is 500 volts each, that registered by V_1, V_2 and V_3 must be $500 \times 1.73 = 865$ volts, since V_1 is the resultant of V_4 and V_6, V_2 the resultant of V_4 and V_5 and V_3 the resultant of V_5 and V_6 at a 120 deg.

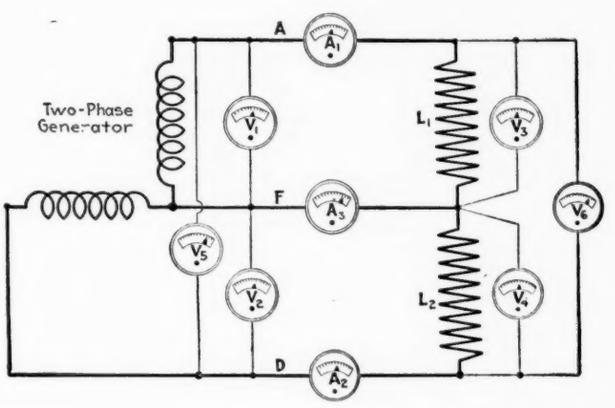


FIG. 2. THREE-WIRE TWO-PHASE CIRCUIT

In a two-phase four-wire system the line current equals load current and the line voltage equals the load voltage. In a two-phase three-wire unbalanced system the current in the outside lines equal the load current, the current in the middle line equals load current times 1.414, and the line voltage equals load voltage.

In a delta-connected three-phase system the line current equals load current times 1.73; line voltage equals load voltage. In a three-phase system "Y" connected the line current equals the load current and the line voltage divided by 1.73 equals the load voltage.

From the previous lesson we found that the apparent power, volt-amperes, equals the voltmeter readings times the ammeter readings, and the true power, watts, equals the volt-amperes times the power factor. The apparent power in Fig. 1 will be $v.\text{-}a. = (E_3 \times I_1) + (E_4 \times I_2) = (500 \times 100) + (500 \times 100) = 100{,}000$ volt-amperes. That in Fig. 2 will be the same. In Fig. 3 the apparent power will the $v.\text{-}a. = (E_4 \times I_4) + (E_5 \times I_5) + (E_6 \times I_6) = (500 \times 100) + (500 \times 100) + (500 \times 100) = 150{,}000$ volt-amperes. In Fig. 4 the power would be the same as that in Fig. 3. It will be seen that in a balanced two-phase system the total apparent power equals the volt-amperes of one phase times

2, and that in a balanced three-phase system the total apparent power equals the volt-amperes of one phase times 3. Hence, if the volts and amperes of one load are known, the entire load of the system can be determined. In many cases, however, the volts and amperes of the load cannot readily be measured, only those of the line being accessible. The question then arises, how are we to compute the power from the line voltage and line current? On first thought we might be inclined to

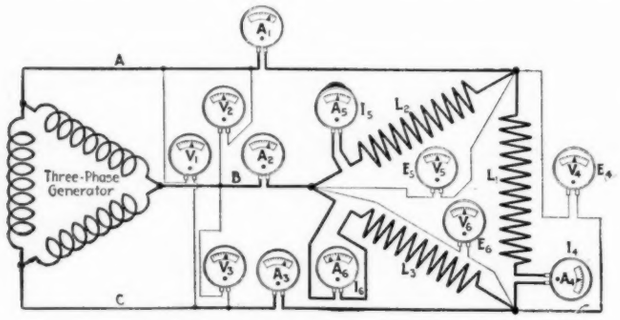


FIG. 3. DELTA-CONNECTED THREE-PHASE CIRCUIT

say it is equal to twice the voltage times the current per phase in a two-phase system, and equal to three times the voltage times the current per phase in a three-phase system. The former of these conclusions is correct, but the latter would be erroneous. To prove the latter consider again Figs. 3 and 4.

In Fig. 3 the line current was found to be 173 amperes and volts per phase 500. In this case, volts $\times$ amperes $\times$ 3 = 500 $\times$ 173 $\times$ 3 = 259,500. In the "Y" connection, Fig. 4, the line current was found to be 100 amperes and the volts between phases (lines) to be 865; then volts $\times$ amperes $\times$ 3 = 865 $\times$ 100 $\times$ 3 = 259,500 amperes. But the apparent power was found to be only 150,000 volt-amperes. If we divide 259,500 by 1.73, there is obtained an answer 150,000, which corresponds to the correct value of volt-amperes. This shows the line volts times the line current times 3 to be 1.73 times too great, which is what would be expected since the line current in a delta connection is that of one phase times 1.73 and the voltage between lines in a "Y" connection is 1.73 times that of one phase. The constant 1.73 is the square root of 3, therefore since the voltage in one case is increased by the $\sqrt{3}$, and in the other case the current is increased by $\sqrt{3}$, the apparent power in a three-phase circuit will be equal to the line current times the volts between the lines times the $\sqrt{3}$ (1.73), or in Fig. 3 volt-amperes = 173 $\times$ 500 $\times$ 1.73 = 150,000, and in Fig. 4 volt-amperes = 100 $\times$ 865 $\times$ 1.73 = 150,000. Hence the apparent power of a balanced three-phase circuit is $v.\text{-}a. = EI \times 1.73$, where E is the voltage as measured between any two line conductors and I the current in amperes flowing in any one of the three line conductors.

The foregoing has not taken into consideration the power factor of the circuit. Whenever there is inductance in the circuit, which is generally the case, the power factor of a polyphase circuit must be considered as in a single-phase circuit, to obtain the true watts, and is applied the same way in both cases. In a two-phase circuit the true watt $W = 2EI \times P.F.$, therefore in Figs. 1 and 2 if the power factor is 0.80, W = 2 $\times$ 500 $\times$ 100 $\times$ 0.80 = 80,000 watts. The true watts in a three-phase circuit will be $W = 1.73EI \times P.F.$ In Fig. 3 if the power factor is 0.80, the true watts will equal W = 1.73 $\times$ 500 $\times$ 173 $\times$ 0.80 = 120,000, and in Fig. 4, W = 1.73 $\times$ 865 $\times$ 100 $\times$ 0.80 = 120,000 watts. The power factor in a balanced polyphase system—two-phase or three-phase—is the same as for single-phase system; this is, *power factor* = $\frac{\textit{true watts}}{\textit{apparent watts}}$. There is no standard definition of what the power factor of an unbalanced polyphase system is. However, the question is now under consideration by the electrical engineering societies, and no doubt some standard will be adopted in the near future.

In the first problem given in the previous lesson, the reading of the voltmeter was given as 230, that of the ammeter 175 and of the wattmeter 35 kw., to determine the volt-amperes, kilovolt-amperes, power factor and the phase angle between the current and the voltage. The $v.\text{-}a. = EI = 230 \times 175 = 40{,}250$; $kv.\text{-}a. = \frac{v.\text{-}a.}{1000} = \frac{40{,}250}{1000} = 40.25$ kilovolt-amperes; and the power factor $P.F. = \frac{kw.}{kv.\text{-}a.} = \frac{35}{40.25} = 0.87$. Referring to a table of sines and cosines and finding an angle whose cosine is equal to the power factor, 0.87, will give the phase angle between the current and voltage. In this case it is found to be approximately 29 deg.; that is, the current is approximately 29 deg. out of step with the voltage.

In the second problem the power factor was given as 0.80, the wattmeter reading 75 kw. and the voltage 440, to find the ammeter reading, the volt-amperes, kilovolt-

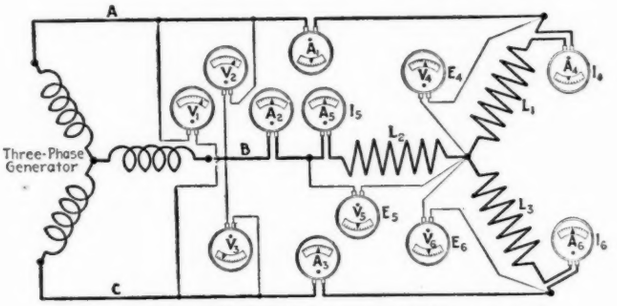
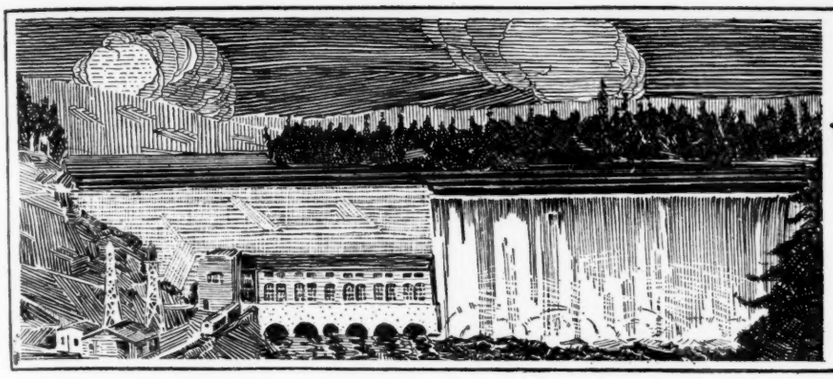


FIG. 4. STAR-CONNECTED THREE-PHASE CIRCUIT

amperes and the phase angle between the voltage and current.

The ammeter reading in a single-phase circuit, where the watts, volts and power factor are known is, $I = \frac{W}{E \times P.F.}$ In this problem $I = \frac{75 \times 1000}{440 \times 0.80}$ equals 213 amperes; kilovolt-amperes, $kv.\text{-}a. = \frac{kw.}{P.F.} = \frac{75}{0.80} = 93.75$. The phase angle between the voltage and current in this problem can be found the same as in the previous one, by referring to a table of sines and cosines and finding an angle whose cosine is equal to the power factor, 0.80. This angle will be found to be approximately 37 degrees.

The ammeters in the lines of a 600-volt three-phase system each indicate 400 amperes. The power factor of the system is 78 per cent. The load is connected delta. Determine the power furnished to the load, voltage and current of each leg of the load. Determine the foregoing quantities when the load is connected "Y" and has a power factor of 72 per cent., assuming the same line voltage and current as in the foregoing.



POP'S WATER-POWER COURSE

By John S. Carpenter

"JES' hand me that drawin' board with them compasses an' pencils," said the old chief. "Tonight we sees how they finds the number of buckets they puts on them there Pelton wheels we've been a-studyin' about, an' a few other little things." With a significant glance, he added, "An' they don't do it by throwin' up a coin or shootin, any craps over it, either."

"Here's your tools."

"Fig. 1 shows how they finds the theoretical spacin' of the buckets. This time we'll confine our argyments to a wheel 18 in. in diameter on the stream line an' havin' a 2-in. stream or jet. That jes' makes a ratio of 9, an' you'll see that the stream is set in from the outside of the wheel to the center line jes' 2.6 in., the same bein' 1.3 times the diameter of the jet. The diameter bein' 18 in., an' addin' to that twice 2.6 in. gives us an over-all diameter of 23.2 in. Now, this is a pretty low ratio wheel, an' in such a case we likes to reduce the speed a little on the stream line so the speed on the outside of the wheel ain't too high. So we uses 45 per cent. of the spoutin' velocity on the stream line, which gives us 50 per cent. on the outside of the stream or 58 per cent. on the outside of the wheel. I might say here, to forestall any pile drivin', that this 58 per cent. is a bit high, but it won't cause any trouble if they is buckets enough and the outside end of 'em is lengthened out a bit so the tail end of the cut-off portion of the jet gits a little time to react. Drawin' this to scale, we can measure distances down to a gnat's eyebrow an' avoid figgers almost altogether. Drawin' in the circle tangent to the outside of the stream, we begins at the vertical center line an' spaces off some small distances about half an inch long, no partic'lar length bein' needed, only we must remember to stick to that distance once we make it. Number these spaces on the circle 0, 1, 2, 3 an' 4. Very well, that's done. Now from the center line at 0 start an' lay off equal horizontal distances as shown by the points *a*, *b*, *c*. The spaces on the circle is the distances the wheel would move in a very short time, and the spaces on the horizontal line is the distances the stream would travel in the same time that the wheel takes to go them small spaces 0, 1, 2, etc. On the outside of the stream I told you the wheel speed is 50 per cent of the stream or jet speed, so them last spacin's must be jes' twice as long as the circular spaces. See?"

"You mean because the water travels twice as fast as the wheel?"

"Yep! Now then, swing circles around through them points *a*, *b* an' *c* with *M* as a center. Next, draw radial lines from *M* through them points 1, 2, 3, cuttin' the circular arcs to which they belongs at places *A*, *D*, etc. Now the distance from *C* to *A* is the amount the wheel will move while the water moves from *C* to *a*, leavin' the small piece from *A* to *a*, this bein' the relative velocity of the water with respect to the wheel, or the difference in speed between the water and the wheel. In the same way the distance *D* to *b* is the relative velocity at point *b*. Lay off these distances from the center line *MZ*, which gives you *C* to *B* an' *E* to *F*,

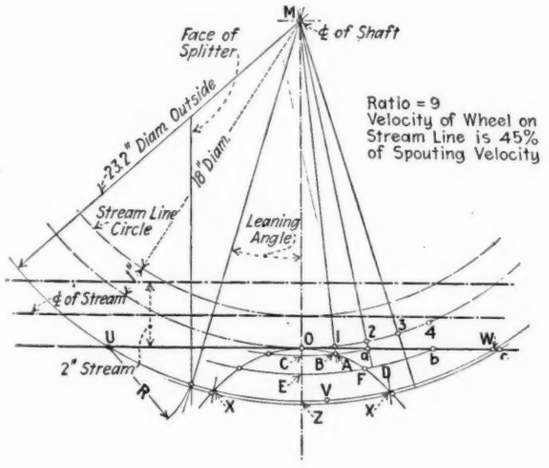


FIG. 1. SHOWING THE METHOD OF FINDING THEORETICAL SPACING OF THE BUCKETS

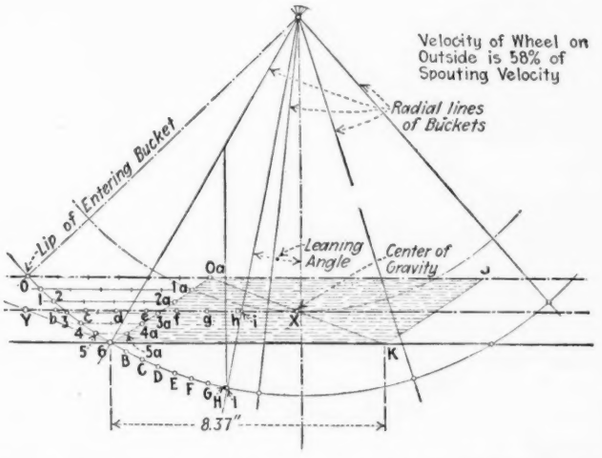

Velocity of Wheel on Outside is 58% of Spouting Velocity
Radial lines of Buckets
Lip of Entering Bucket
Leaning Angle
Center of Gravity
0a
0 1 2 1a 2a
Y b 3 c d e 3a f g h i X
4 4a
5 6 5a
B C D E F G H I J K
8.37"

FIG. 2. SHOWING HOW STREAM IS CUT AND GRAPHICALLY FINDING LEANING ANGLE

an' do the same with the outside circle on point *c*. Now hand me that French curve over there."

Pop carefully fitted the curve to the three points he had located and also the tangent of the circle at *O* and drew in the curve *O* to *X*. Then the curve was turned over and the other half drawn in, giving the irregular curve *XOX*, cutting the arc of the outside of the wheel as shown.

"Now," said the old chief with an air of triumph, "they don't dare space them buckets any farther apart than from *X* to *X*, measured on this here curve. Measurin' the distance around, it is jes' 5.5 in., which, divided into the circumference of the circle, the same bein' 23.2 x 3.1416 = 72.8 in., gives 13.22 buckets theoretical. To prevent water slippin' by the wheel unused, they usually allows from 15 to 20 per cent more, which in this case would give us 15 buckets, since it is a high-speed wheel an' we'll have trouble enogh to git 15 bukets on the wheel, well fastened. In a little bit I'll come back to the subject of water slippin' by the wheel unused."

"I think I get your explanation of the method, Pop, but there must be another way of finding the spacing, too." Jimmy pointed his cigar at a rakish angle and bent over Pop's drawing. "Now follow me. Suppose, Pop, we have a bucket at *U* and a drop of water starts away from *U* at the same time the bucket edge does. If the space was clear, the drop of water would tend to go clear across to *W*, and then it would be beyond the influence of the buckets. Since the bucket moves at 58 per cent of the water velocity, for every inch that the water drop moved on the horizontal line, the bucket would move 0.58 in. around on the circular arc. I measure the horizontal line *UW* to be 11.75 in. long, and the distance around on the circle as"—Jimmy painfully stepped off the distance around on the arc between *U* and *W*— "12.32 in. During the time that the water moves from *U* to *W*, which is 11.75 in., the bucket lip or edge moves 58 per cent of this, or 6.82 in., and deducting that from your circular arc length, 12.32 — 6.82 = 5.5 in., the same as you got with all your fussing with curves!" Jimmy glanced teasingly at the dazed and crestfallen Pop.

"You mean," began Pop quite apologetically, "that you must have a bucket at *W* to catch the last drop there, don't you? You only said your bucket got to the place marked *V* an' then you hopped to a conclusion, like a woman's reason—'because.'"

"Of course, Pop, I'll gladly give you credit for that, and I'll also say that your method is quite a bit more handsome."

With his composure and gravity quite recovered, Pop cleared his throat and brought up the heavy artillery. "Now, young feller, do you see that point *O*, on the vertical center line? Well, there the water is strikin' the bucket right parallel to the direction of its rotation. It doesn't matter where I draws in the curve, whether it is at *U* or at *O;* I jes' drew it in at *O* 'cause there I could show you, like the lecturer showed me, that the water strikes the bucket square. Now it's plain that when the water strikes the bucket square, it should be at right angles with the stream at that place. So you takes the distance *X* to *Z* on your compass an' strikes the arc *R* from *U* as a center. Drawin' a radial line to the center *M* of the wheel, we gits the angle that the bucket should lean, the same bein' called the leanin' angle. Therefore the old rule of thumb that Pelton wheel designers allers used, that the leanin' angle should be half the angle between two buckets. Where we uses more than the theoretical number of buckets, you take, of course, half of the angle correspondin' to the number that you uses.

"Like you showed me on your idee of findin' the bucket spacin', you can find the leanin' angle, too—only a little different. Glue your lamps to Fig. 2 for a spell! This shows us how the stream is cut by the lip of the enterin' bucket. A drop of water at the top of the stream at *O* moves to *0a* while the bucket moves through the stream, an' in the same way a drop at v moves to *1a* while the bucket moves to 6. Followin' 'em all out thataway, you gits the points *(0a, 1a, 2a, 3a,* etc. to *6*. Then drawin' in the curve through these points, you gits the shape of the cut. Now to git the length of the slug of water. We figgered to use 15 buckets on the wheel, which brings 'em 4.86 in. apart measured on the circle. Since the wheel moves 58 per cent. as fast as the water, divide 4.86 by 0.58 an' you gits 8.37 in., the length of the solid slug. At the end of the slug you can draw in the same curve *JK* that you drawed in at the beginnin', and then you has the exact shape of the thing. Now, draw a diagonal line cuttin' the center line of the stream at *X*. This place is the center of gravity of the slug and corresponds to the point *O* in Fig. 1. Now, to show how it works, I'm a-goin' to transfer the point *X* to the next slug comin' along, which is then at point *Y*. Rememberin' that the wheel moves jes' 58 per cent. of the water velocity, an' considerin' the bucket lip to be at *6*, we'll

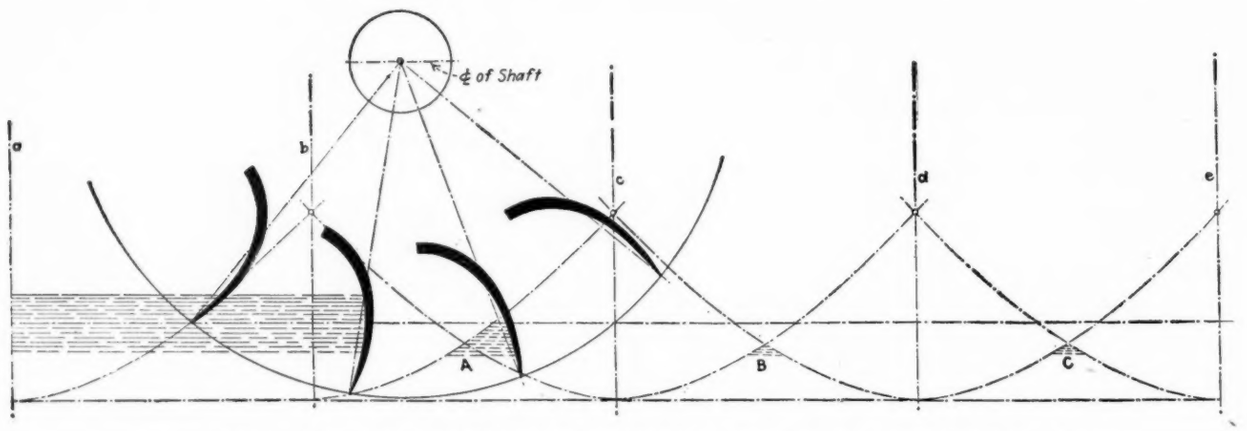


FIG. 3. SHOWING SECTIONS OF JET ESCAPING UNUSED DUE TO TOO FEW BUCKETS

go ahead. While the drop of water at Y moves to *b*, the lip has moved from *6* to *B*, an' so on until the bucket lip gits to *H* on the straight line an' to *h* on the curve. At that place they is still a wee piece until the drop of water at *Y* would touch the radial line of the bucket lip, and proportionin' the distance between the two points we're jugglin', you sees the point *Y* overtakes the radial line at point *i* on the curve. Now if you'll jes' measure around the curve from *6* to *I*, you'll see that it is so close to one-half the distance from *X* to *X* in Fig. 1 that they's no fun in it. In real scrappin' this method is not exactly right, 'cause most designers argues that the bucket should be set square with the stream when the center of gravity is at the bottom of the curve of the bucket while others says it should be at the discharge edge of the bucket. So you sees they's plenty of room for a good scrap. However that may be, I thinks it should be at the bottom of the bucket, but the facts is that most designers makes the leanin' angle half the angle between two buckets an' lets it go at that, 'cause a few degrees one way or t'other ain't gonna kill the efficiency." Pop looked at Jimmy expecting a flare-back. "You look like you gonna say somethin' mean in a minute, so spit it out!"

"No, Pop, nothing mean; I'm just thinking that you once told me that the analytical design of Pelton wheels is complicated. I believe you told the truth."

"I said awhile back that I was gonna return to the subject of water gittin' through the wheel without doin' useful work. Now, son, they's oftentimes in power-plant operation when heavy load changes occurs an' when the wheels speed up quite a bit if the load goes off. For full load off, the changes in speed, especial if they's a long pipe line or the velocity of the water in it is high, then you can't use a quick-acting governor. In sich cases the speed may go up 20 to 25 per cent, which is the same at those speeds as if the wheel didn't have enough buckets on it. Then the water is gonna slip through and spatter on the housings of the wheel like machine-gun fire. If the water is under high head, it will dern soon begin to wear through the cast-iron or steel housings an' raise the divil in general. The same dope applies to a wheel designed with too few buckets for its normal speed. On Fig. 3 I shows you a case where only 12 buckets was used an' accordin' to our figgers, we should have 13.22 buckets theoretical. You'll wanta know how I got that bucket curve. Well, I just forgot that the stream was any particular size and extended the method used to find the outline of the ends of the slug in Fig. 2, indefinitely. Them vertical lines *b*, *c*, *d*, etc., is just the length of the slug apart, in this case bein' 10.5 in. For every bucket that goes through the stream, a small part like *A*, *B*, *C*, etc., goes through unused. When you figgers that they's maybe 4000 of 'em per minute, you'll soon see that this means loss in efficiency. Then, besides the loss in power they's a lotta racket with all that water goin' agin' them housin's. It would give me the jimjams sure as blazes!"

Under the Federal law, which declares that it shall be unlawful to use a locomotive in moving interstate traffic unless the boilers and appurtenances are in proper condition, a railway company or its receivers are liable for the death of an engineer in a boiler explosion due to defects in the bolts and stays designed to sustain the crown-sheet. (Texas Court of Civil Appeals, Lancaster vs. Carroll, 211 Southwestern Reporter, 797.)

Steam Boiler Policies Interpreted

By A. L. H. Street

A policy carried by plaintiff company with defendant insurance company indemnified the former against loss on account of the explosion of seven vertical-tube boilers used in a power plant at Ithaca. A clause in the contract provided that the term "boiler" in the policy should "mean any receptacle or vessel enumerated and described" in the contract "as such, in which steam is generated or used, and shall include the steam, feed and blowoff piping to and including the stop valve nearest the boiler in any of such piping, also the water column, safety valve and all steam and water gages." Other parts of the contract indicated that the boilers insured against explosion were intended to include only the seven boilers proper.

An explosion, causing great damage, occurred in an economizer connected with boilers Nos. 1 and 2. The defendant resisted liability under the policy and suit followed. A jury returned a verdict in favor of the plaintiff for $25,000, but the New York Supreme Court has reversed the decision, holding that, since the economizers were merely used to heat the water before passing it to the boilers proper, they are not to be regarded as covered by the policy. It is also held that a valve between the boilers proper and the economizers, shutting off the flow in either direction, was a "stop valve," within the meaning of the clause of the policy referred to, extending the insurance "to the stop valve nearest the boiler." Further reason for excluding an economizer as a "boiler" is found in the fact that the policy specified that the word "explosion" should cover a "collapse of the boiler . . . or its flues." (Ithaca Traction Co. vs. Travelers' Indemnity Co., 177 New York Supplement, 753.)

Safeguarding Employees Against Injury

By A. L. H. Street

The Texas Supreme Court has affirmed a judgment denying the right of an engineer employed in an electric power plant to recover damages for injuries sustained when he tripped over a wrench on a floor, thereby causing him to fall against the frame of an exciter and his hand to enter the machine. (Taylor vs. White, 212 Southwestern Reporter, 656.)

The plaintiff unsuccessfully based his claim on the grounds that the defendant, as receiver of the plant, was negligent in failing to have a guard rail about the exciter and in permitting the wrench to be on the floor. The court lays down these general rules specially applicable to all sorts of power-plant employees:

Where a machine is so constructed as to contain no openings except those designed to permit adjustments and cleaning, and is constructed in the manner very common or universal in other plants of the same kind, and where an employee injured in contact with the machine is experienced and familiar with the surroundings, he cannot recover for such injury.

An employer is not an insurer of the safety of his employees, being merely pəɹnbəɹ to use that degree of care which an ordinarily prudent person engaged in like business would use under like circumstances. Where machinery is maintained in a customary manner, the burden rests on an injured man to show that, despite the custom, the maintenance in the particular way was negligence.

An experienced power-plant employee familiar with all his surroundings assumes the risks of injury naturally inhering in the work he is required to do.

Selecting Leather Belting

By Ernest E. Elder

Whether the ruling power of the power house is designated a chief engineer or known as "Joe, down in the engine room," he has more or less to do with belts. Either he buys the belting for his company directly or he recommends to the purchasing agent or the superintendent, who does the buying, what brands or grades should be procured. In some cases he is disregarded in such matters and generally to the company's disadvantage. It may prove of advantage to the power-house man to know a few of the "whys" of the belting end of his business.

It must be borne in mind that leather grows and is not made, and so, contrary to practically everything

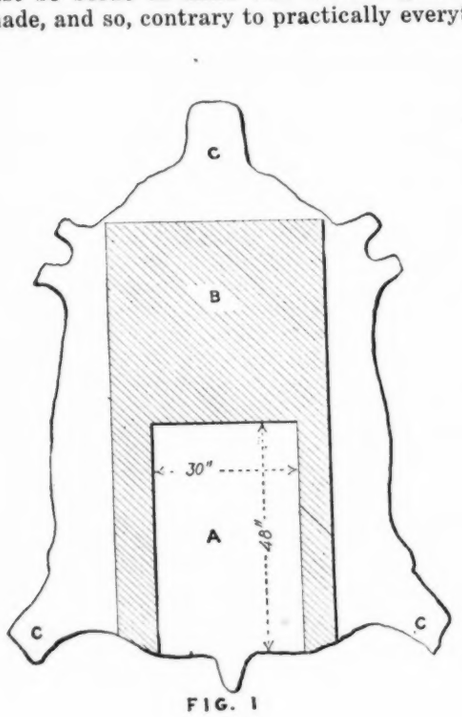


FIG. 1

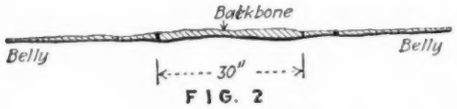


FIG. 2

FIG. 1. GREEN HIDE, SHOWING BELTING BUTT. FIG. 2. CROSS-SECTION OF HIDE

else in the mechanical world, does not have a uniform composition. Every hide varies in thickness, in texture, in tensile strength, in percentage of stretch and in many other ways throughout its area. Also one hide differs from another, so that a leather belt made up of portions of many different hides must be carefully selected and carefully made to insure a strong and uniform product.

Fig. 1 shows the general shape of a green hide as taken from the animal. At the tannery the head, flanks and lower belly pieces, marked *C* in the figure, are trimmed off and used for purposes other than belting. The part *B* remaining is tanned for a belting butt. After tanning, the shoulder end of this belting butt is trimmed off to be used in cheaper-grade belting, in welting or in some other way, while the part *A* is used for first-grade belting. Right here is a vital point in the making of the belt.

How much of the belting butt is shoulder? Some manufacturers trim off all shoulders 60 in. from the tail, making the sectional pieces in the finished belt practically all 60 in. long; others trim at 54 in., others at 50 in. and a very few at 44 in. Obviously, the shorter the trim, up to a reasonable point, the better and the more expensive the belt. The main advantage in a short trim is that beyond 40 in. from the tail the average hide runs thinner and the fibers are more loosely knit. In other words, if a belt is made up of sectional pieces 48 in. or under in length, including the lap, we can be sure that this belt is as near uniform as to fibrous composition and thickness as is possible to make it.

What has been said regarding the shoulder end of the belting butt may also be applied to the belly portion, or that part parallel to and farthest from the backbone. A cross-section of a belting butt about 20 in. from the tail is shown in Fig. 2. For a distance of about 15 in. on either side of the backbone the substance is fairly uniform, but beyond that point it is less uniform and the fibers are more loosely built up.

From the foregoing it is seen that first-grade belting is made from a portion of the hide 48 in. from the tail and 15 in. on either side of the backbone, or approximately 10 sq.ft. from each hide which measures when taken from the animal about 40 sq.ft. Thus only 25% of first-grade belt leather can be obtained from each hide.

How shall we set about determining whether any particular belt has been made from this portion of the hide? By a test of tensile strength? No, for the tensile strength in a hide is greater in the shoulder and belly than along the backbone in practically all cases. Also because no two sectional pieces will show the same strength under such tests. By the amount of wrinkles, or "pipe" as it is called, which show on the grain of the belt when bent grain side in? No, for it is possible to curry a piece of leather without stretching, which will show practically no "pipe" even in the belly and shoulder portions. (The currying of leather is the stuffing with greases and oils, the setting out of the fibers and the stretching, and is a process between the tanning and manufacturing of the belt.) Also many imperfections of the grain in the belly and shoulder portions can be obliterated by buffing and straining.

Obviously then, the best way to buy high-grade leather belting is to deal with a reputable manufacturer who will gurantee that his first-grade belts are made from leather tanned and curried in the best possible manner and cut from that portion of the hide 48 in. from the tail and not over 15 in. either side of the backbone. Naturally, there are drives in every power house, as in every machine shop or factory, that are relatively unimportant, that do not operate continuously, but that must remain belted up. These should be driven by second- or third-grade belts, as it is not a paying proposition to have a first-grade belt on such a drive.

EDITORIALS

Regular Publication Resumed

ON account of labor troubles, due largely to disagreement among the unions, *Power* has not appeared regularly for several weeks. We regret this interruption of our service and communication with our subscribers and are glad to announce the completion of arrangements whereby the regular appearance of the paper has been resumed.

We could not avoid the strike, but now that service is resumed we are determined that the reader shall lose as little by its interruptions as possible. To the end that he may receive his full number of issues, we shall mail the paper at, as nearly as may be, intervals of six days, and beginning with the next issue will combine in each the reading pages of two ordinary issues. In this way we shall be able to complete the full fifty-two numbers of volume fifty by the end of the year, and to start the new volume at the commencement of 1920 on the regular date of publication and with the regular number of pages. The issue of October 14 bore the publication date of November 22, but following issues will bear their successional dates with the date of publication appended.

One of the fine things about the strike has been the splendid assurance of approval and support that it has brought from our patrons, subscribers and advertisers alike. Most of them have realized that we are contending not against an ordinary appeal for industrial betterment, but against a breach of contract so flagrant that its perpetrators were ruled out of their own union for persisting in it, and against demands so confiscatory as to suggest being a part of the syndicalists' program. In resisting these demands we have been fighting not our fight alone, but the cause of safety against unreasonable aggression of property and opportunity.

Fuel Oil Situation In The East

SOME four or five years ago fuel oil began to find a steadily growing market along the Atlantic coast, particularly in New England, remote from coal fields and where coal is high in price. Then came the war and later the taking over by the Government of the oil tankers which brought this topped crude out of Tampico. Delivery became less and less certain. The market was not dormant, however; interest in oil as boiler fuel continued keen.

In the face of this situation the owners of the Tamarack Mills in Pawtucket, Rhode Island, engaged Jenks and Ballou, engineers, of Providence, to design and build a modern steam-turbine power plant using oil as fuel. This station is noteworthy in that no provisions whatever for coal storage and handling were provided. Even the chimney was designed upon an oil-burning basis. This plant was erected after a year or more of experience with oil after changing from coal to oil in the plant of the Jenks Spinning Company, owned by the same people who own the Tamarack Mills. The performance results in both plants excited interest and were given in *Power* at the time.

About this time several plants were experiencing trouble with boiler-room labor, firemen being particularly restless. It was partly to get away from this constantly recurring trouble that one of the largest mill owners in Massachusetts changed from coal to oil. Of course there were other reasons, cost reasons, for making the change; but because oil would enable the steam demands to be met with fewer men in the boiler room with oil than with coal, the liquid fuel was adopted. Since then other plants have pursued a similar course. The Quincy Market Cold Storage and Warehouse Company, Boston, a heavy consumer of fuel, is now equipped to burn oil in its Richmond Street Station and soon will be ready for it at its large plant at Sargent's Wharf.

The coal market certainly was never more forbidding than at present. Prices have been very high for four years now, and the outlook is that they will go higher instead of remaining stationary or coming down. Perhaps the situation is reflected in the activity of what is possibly the largest coal company in New England; namely, the New England Fuel and Transportation Company, Boston. This company, through the Beacon Oil Company, recently organized, is building a refinery at tidewater at Everett, Mass., with capacity for six thousand barrels a day and six million barrels storage capacity. Unless the steel strike too long delays, this refinery will be in operation within the next six months. A little down the coast, near Fore River, the Massachusetts Oil Company is building a large refinery. Both refineries will transport Mexican crude direct from Mexican ports.

A few years ago the American Oil Engineering Company was organized in Boston. It will do consulting engineering as it relates to oil and oil burning.

The demand for fuel oil may be judged by the fact that the Mexican Petroleum Company and the Standard Oil Company have about reached the limit of their transportation facilities. Of course this situation is monetary, one may say; nevertheless it shows how great is the demand.

And the demand is not confined to New England. One finds it growing in New Jersey, New York and Eastern Pennsylvania, particularly in the Philadelphia district. New York City, which heretofore forbade its storage in buildings, is now drafting rules for its storage and use. All these places have large coal terminals.

The intelligent engineer will admit that oil makes a convenient fuel; he appreciates that changing from hand-firing coal to oil usually brings, merely because of the difference in fuels and the finer, more easily controlled combustion of oil, an increase of about six per cent in combined boiler and furnace efficiency, though it is possible to attain as high efficiency with coal as with oil; he knows it will greatly cut labor costs and troubles in a large boiler plant; the elimination of ash handling and cartage he appreciates; its, up to the present at least, low comparative price encourages him. But—there is usually a "but" to every good thing—while admitting all these advantages; he stumbles on the question of supply and delivery. How certain can he be that he will find oil available for an indefinitely long period or a comparatively short definite time? The

answer is that no one knows how much oil is in the ground; that the Mexican fields, which are the fuel-oil fields because of the heavy crude, show increased production; that, recently, oil has been found in plenty, it is reported, in Colombia. More than one American company is now prospecting in South America and with success. But the real answer is that he can make a three- and possibly five-year contract, which comes near assuring him of getting his money back on the investment at least.

It is not to be imagined that oil is going to seriously affect the coal demand by power plants. Neither is it to be presumed that the oil supply is such that it will meet the rapidly growing demands for a great many years. Perhaps it will; but more evidence is needed.

Length Of Longitudinal Joints

THE contribution by C. E. Stromeyer on page ??? to the discussion on the allowable length of longitudinal joints will be read with interest—firstly, because of Mr. Stromeyer's eminence as an authority upon boiler design, and secondly, because he takes a view diametrically opposed to all of the American authorities and all of those who have heretofore discussed the question:

The Massachusetts Boiler Rules say:

A horizontal return-tubular, vertical-tubular or locomotive-type boiler shall not have a continuous longitudinal joint over twelve feet in length.

The Boiler Code of the American Society of Mechanical Engineers says:

In horizontal return-tubular boilers with lap joints no course shall be over twelve feet long. With butt and doublestrap construction longitudinal joints of any length may be used, provided the tension test specimens are so cut from the shell plate that their lengthwise direction is parallel with the circumferential seams of the boiler, and the tests meet the standards prescribed in the specifications for boiler plate used.

We are curious to know:

Why the Massachusetts Board considers both lap and butt-strapped joints dangerous in lengths exceeding twelve feet while the Boiler Code Committee of the A. S. M. E. is apprehensive for lap joints only.

Why the Board of Boiler Rules prohibits these joints on horizontal return-tubular, vertical, and locomotive and the A. S. M. E. only on horizontal return-tubular boilers.

If they are dangerous in the shell of a locomotive-type boiler, why they are not equally dangerous in the drums of water-tube boilers?

All the members of the Board of Boiler Rules and most of those of the A. S. M. E. Committee decline to discuss the question, although their constituencies may reasonably be curious as to why the poor old horizontal return-tubular is singled out to take the whole brunt in one case and why in both cases the inhibition is confined to boilers of three types.

Both the Massachusetts Board and the A. S. M. E. Committee and all who have discussed the matter agree that the long joint is bad and should be avoided. And now comes Mr. Stromeyer and says that he is strongly in favor of long seams, and prefers them to short ones even if the plates are rolled parallel to the seams. His statement of the stresses set up in the solid sheets opposite the ends of the joints is very interesting. One would suppose that, stressed to that extent, the sheets would show some signs of corrosion or other distress. We shall be glad to have the thoughts of other designers regarding it.

A Move To Perpetuate Power Economy

DURING the war the work of the United States Fuel Administration resulted in the gathering of a vast amount of data and information on the subject of fuel economy. From a study of some of these data, rules and suggestions for more economical processes in conjunction with fuel were issued. These rules and suggestions, which covered the production, distribution and consumption of fuels, resulted in great advantage to everyone.

With the passing of the war-time emergency this activity ceased when it was just at the beginning of its possible usefulness. The questions now come up: Are all these data to be thrown away and the work wasted? Are we to go back to pre-war wasteful methods, or will we continue to get help from the war-time work? Obviously, if any permanent results are to be obtained, the work of the Fuel Administration must be continued, at least in part. The scope of the work and the power that the body carrying it on would have to have, make it necessary that it should be done by Government agency instead of by any private interests.

With the hope of solving some of these problems the International Power Economy Conference was formed. An account of the second meeting of this conference appears in another column of this issue.

Some such action as is proposed by the conference seems especially necessary now. The present situation in the coal-mining industry makes fuel economy a very important question. And it will continue to be an important question. No matter what agreements may be made with the miners, this year, or next year, or in the more distant future, the fact remains that the most rigid fuel economy is a vital, national need. Ignorance, personal interest or personal indifference must not be allowed to continue the old-time wasteful practices. It should be the business of every American citizen to see to it that proper steps are taken to preserve the results of, and to continue the work already done toward, national fuel economy. This is "everybody's business." May the International Power Economy Conference be able to prevent it from becoming "nobody's business."

Why Not Limit Life Of Lap Seam Boiler?

Again the lap seam boiler. This time an explosion resulting in no fatalities but in property damage approximating $10,000, as explained on other pages of this issue. The lap seam design has been a prolific source of accident, usually severe and frequently fatal, and the treacherous part of it is that the initial flaw or weakness is usually invisible to external inspection. The weakness of the design has been realized for years and in the standard boiler code of the day, precautions have been taken to prevent the sale or use of new boilers of this type. Unfortunately the code has not been adopted universally and even where it is in effect, such designs are allowed to continue in operation. Eventually there will be no lap seam boilers, but why not hasten the day. Limiting their useful life to a comparatively short period, say ten years, would sooner rid the country of a design known to be faulty and by eradicating one of the chief causes of accident, reduce the number of boiler explosions and the resulting fatalities and damage.

CORRESPONDENCE

Blowing Down Boilers

Referring to the editorial on page 472 of the Sept. 16 issue of *Power*, the question comes, Why blow down "one gage" on a boiler every shift? Why not "one-half gage"?

From my own experience I think that less water blown at a time, but more often, would be better. When opening the valve I have noticed that you can feel or hear the fine scale leaving the boiler. This could be noticed only about as long as it took to open the valve wide. This led me to try some experiments on three return-tubular boilers.

First, I had one gage blown out twice every twenty-four hours for two weeks. Then after cleaning, one of the boilers was blown just long enough to open and close the valve, which in this case was a quarter-turn valve. When this boiler was taken off for cleaning, no difference could be seen. Of course if very poor water is used without a water softener, more blowing would be required.

I have been on the road with large locomotives when the blowoff valves would not be opened for 36 hours, and had no trouble from priming. Why should stationary boilers be blown so often when it is not done in locomotive practice? L. A. COLE.

Columbus, Ohio.

It seems likely that the noise heard, on opening the valve, was due to the rush of water through the partly opened valve. This does not lessen the importance of Mr. Cole's suggestions.—Editor.

Better Cylinder Oil-Testing Methods

Wilbert Walton Cranford, on page 314 of the Aug. 19 issue, asks how I test cylinder oils. In reply I would ask that Mr. Cranford read my letter on "Testing Cylinder Oils," page 256 of the Feb. 18 issue.

In the final windup every engineer must test his cylinder oils on an engine; however, it is not essential that the oil be tested on the engine in which it is used, provided the steam conditions (moisture, super-heat and priming) are approximately the same.

In practice it is neither necessary nor advisable to test out cylinder oils frequently with a view of making a change in the brand. There are many reputable oil concerns that take pride in supplying suitable oils to the customers in their district. The difficulty is that too many concerns want the cheapest thing they can find regardless of quality. In some cases an old fogy mill superintendent, who has always used a cheap cylinder oil, will not consider the purchase of an oil that may cost more than twice what he has been paying. He prefers a stock compounded with 2 or 3 per cent. animal oil made from fertilizer carcasses and full of oleatic acid.

There are several well-known brands of cylinder oils that smell good enough to eat, and they are good oils for any cylinder. I have found the smelling test to be very reliable, as straight mineral oils can be spotted at once. Pennsylvania cylinder stocks can also be assured, as Western asphalt stocks smell considerably different, having a strong tarry odor. The refining process also has considerable to do with the odor. The smelling test can be learned easily by selecting well-known oils. Smell the oil when hot in a can or pot; then heat some of the cheaper oils and notice the contrast.

I have operated 22 engines of the same make, which I have found to be the most difficult engine built to lubricate, because the valves must be copiously lubricated to insure proper governor action, and in all cases I have found the highest-grade cylinder oils cheaper and far more satisfactory than the low-grade oils—to say nothing about the reduced repair bills.

If it is Pennsylvania or Eastern crude, compounded 5 to 10 per cent. acidless tallow oil, the engineer need not worry. The fire test need not exceed 600 deg. even with steam at 200 lb. pressure; the viscosity has practically nothing to do with the quality. The heavy, draggy oils are an indication of Western stock and poor refining and filtering. Red filtered stocks are preferable to dark stocks, as the latter have a tendency to produce "sweat corrosion" in the cylinder while shut down. Oil refiners do not push the sale of red filtered stocks because it is necessary to compound them of heavier oils, they claim, and because the ratio of profit is much less than on dark, draggy cylinder oils; hence they naturally prefer to sell the latter.

Some years ago I tested out to various brands of cylinder oil a box-valve engine running at 133 r.p.m. The cheapest oil cost $1.12 per day, averaged for a month, while the high-grade oils averaged from 78 to 50 cents per day averaged for the same length of time. I could give like data on other similar engines ranging from 75 to 600 hp., high, medium and low-speed, in which the quantity of oil was reduced, in most cases, to about one-half when the high-grade cylinder oils were applied. The service was also much better, and the cylinder barrels invariably shone like a looking-glass.

Franklin, Ohio. WALDO WEAVER.

What Should Be the Maximum Length of a Longitudinal Joint?

In compliance with your request I have much pleasure in sending you a few remarks on longitudinal joints, but in doing so it will be impossible for me to avoid drawing attention to differences of engineering views on either side of the Atlantic. In England human life is idolized almost to the same extent as animal life is idolized in India, and having made boilers almost absolutely safe, fatal boiler explosions rarely reaching a dozen per annum, we feel startled when we read of the number of American boiler explosions. I was shocked, when on a recent occasion I read an address by an American engineer who claimed to be qualified to speak about the practical working of boilers because he had been present at a dozen boiler explosions and had had as many hairbreadth escapes. Such an exciting experience is quite impossible in England, and I cannot help thinking that there must be other causes than the use of long longitudinal seams to account for these numerous explosions. Remove these other causes and the question of length of joints will sink into insignificance. However, the true effect of long joints should be carefully inquired into.

The present inquiry is somewhat analagous to one which Sir H. Maxim addressed to me about 25 years ago, while he was building his flying machine. I had just published my work on "Marine Boilers," and Maxim invited me to meet Professor Langley and discuss the question of lowest factor of safety for the boiler which he was going to place on board his machine. I remember telling him that if he was going to risk his life in the flying machine which was then nearly completed, he might as well run the risk of being blown up by a boiler explosion, and, seeing that the customary factor of safety of five was absolutely safe, no boiler with this factor having ever exploded, he might reasonably adopt a factor of safety of two and a half, for that was the factor of safety during hydraulic tests, which very rarely resulted in failure. But, I added, the calculation of the stresses in his boiler would have to be more precise than was then customary.

Similarly, if American engineers do not mind risking their lives a dozen times, let them continue the present practices; but whenever they propose new departures, they should study them with as much care as Maxim would have had to study the stresses in his proposed boiler.

Some of the spade work of the necessary investigation has fortunately been carried out by me and published in the "Transactions of the Institute of Naval Architects," 1886, Vol. 27, p. 34. I had been using several strain indicators on ships and boilers. One of these instruments made use of the interference bands of monochromatic light and enabled me to measure strains on short spans of fractions of an inch. Roughly speaking, this instrument was able to measure changes of length with an accuracy of one two hundred-thousandth of an inch, and on a span of one inch this minute deformation represents a stress of only 150 lb. per square inch.

With this instrument I measured the strains in the solid plate of boilers on either end of lap joints, and also in the solid plates above and below the then customary single-butt-strap joint of the hulls of iron ships. My observations showed that the strains in the solid plates close to the ends of lap joints were eight times greater than those in the solid plates away from the joints. Assuming that these joints had only 70 per cent. of the strength of the solid plate, it is evident that the plates that adjoin lap joints are stressed about five times more severely than the joints themselves. Of course these observations do not extend beyond the elastic limit of the material. They were confirmed, or rather they had been confirmed, by unpublished experiments made in 1874 by the Manchester Steam Users' Association on a full-sized boiler whose solid plates ruptured under hydraulic pressure when the seams gave way.

The conclusion that is to be drawn from these two sets of experiments is that the breaking of joints is a source of weakness and the longer we make the longitudinal joints of boilers the better. This principle could not at the time be carried out in boilers because of the impossibility in those days of rolling sufficiently wide plates, but subsequently many marine boilers have been built with single strakes.

Only two marine boilers built on this principle have failed; but having examined the fractures and analyzed the metal, I have no hesitation in attributing these failures to the steel, which was basic and contained a high percentage of nitrogen.

My experiments on the strain in ships' (hull) plates showed that the strains in the solid plates above and below single-butt joints were twelve times greater than the estimated stresses in the seams. My remarks seem to have had a far-reaching effect, for it may safely be said that before my paper was read every iron ship was built with single-butt joints, but now lap joints are almost universal in ships' hulls, although, as well known, lap joints offer more resistance to the movement of a ship than a perfectly smooth skin.

There is perhaps no need for me to repeat that I am strongly in favor of long seams, and I would prefer these to short ones even if the plates were rolled parallel to the seams; but I have to qualify this remark by saying that it is intended to apply only to steels made by the acid openhearth process. Of this steel it may be safely said that it is absolutely reliable, not a single failure having occurred in any boiler built of this material with a factor of safety of from five to four. What would happen with basic steel is impossible for me to say, for published experiences of failures have been so very discouraging that the Manchester Steam Users' Association has, up to now, refused to sanction its use in boilers and we have therefore no direct experience with this material.

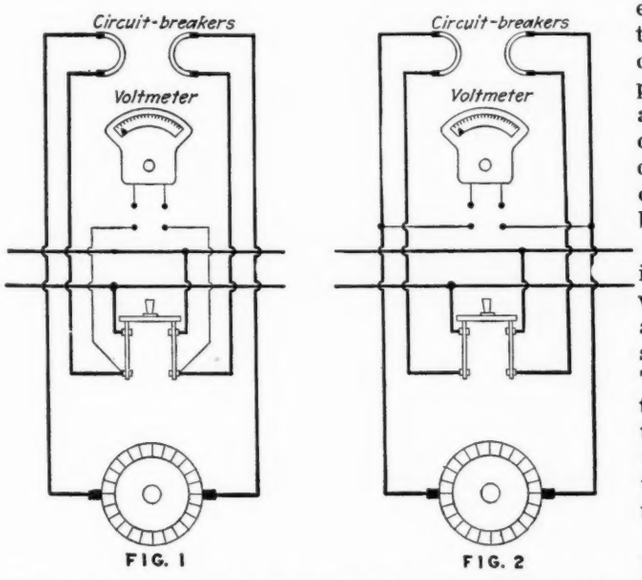
Coming back to my opening remarks, we have been very successful in preventing loss of life. Since our foundation in 1854 up to the present day we have had no preventable explosion although we have issued over half a million certificates of safety; and up to the war we have had no loss of life. The very few failures that have occurred with our boilers have been due either to inoperative safety valves to shortness of water or to scale. These are matters over which we had no control. None of our few failures was due to faulty material or to structural weakness. Under these circumstances we are justified in looking on boilers as being very safe structures, and we would not object to long longitudinal joints. I doubt however whether the same conclusion would be drawn if we had frequent explosions among our boilers, and I hope therefore that

my remarks, which are based on English experience, will not be applied to American boiler practice, which evidently differs in a very marked degree from ours.

C. E. STROMEYER,
Chief Engineer Manchester Steam Users' Association for the Prevention of Boiler Explosions.

Changed Switchboard Connections To Improve Operation

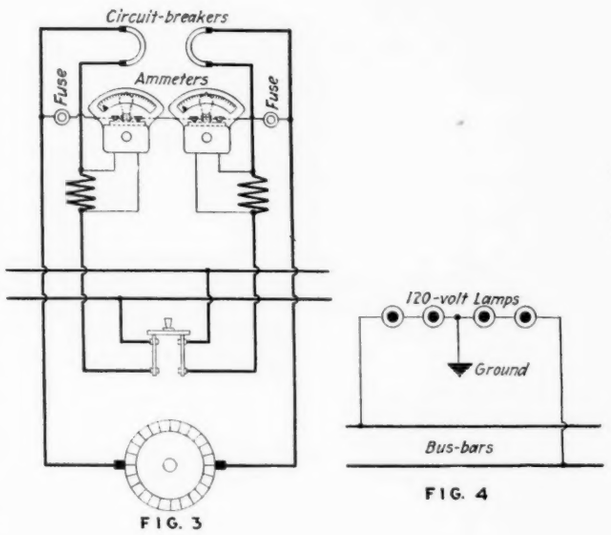
In assuming charge of a power plant several years ago, I found some conditions in connection with the switchboard which seemed radically wrong for efficient operation. In the first place the connection from the plug switches, for connecting the voltmeter with each of the generators for use in paralleling the machine, was connected across the generator leads between the circuit-breaker and the main switch, as in Fig. 1, instead of directly across the armature leads, as in Fig. 2. Consequently no reading would be shown on the voltmeter after the machine was started until the circuit-breaker was closed. The engineer therefore left the circuit-breaker in at all times, pulling the switches on any machine they were cutting off the busbars. This condition was easily corrected by shifting each pair of voltmeter wires directly across the leads coming from the armature of each generator, as in Fig. 2. The practice of putting in the circuit-breaker before the voltage builds up may lead a new or absent-minded engineer to close the main switch with disastrous results. I think it preferable for an engineer to start the engine and build up the voltage before touching anything on the switchboard, other than the field rheostat and voltmeter switch; then he's playing safe.



FIGS. 1 AND 2. VOLTMETER CONNECTED TO GENERATOR SWITCH AND DIRECT TO GENERATOR

Another thing, the illumination for the switchboard meters was provided by individual 120-volt lamps behind each dial. Each lamp was supplied with current by a pair of wires running across the back of the switchboard. This was all right for the voltmeters, but with the ammeters it meant either burning the light on the meters on machines not in service, or getting a ladder each time the generators were changed over and shifting the lights or leaving the lights out. As might well be imagined, the lights were always out. This was changed as follows:

The line voltage being 240, the lamps behind the two ammeters on each machine were connected in series across the armature leads of the respective generators, as in Fig. 3. Thus, when a machine started the lights gradually lighted up as the voltage increased to normal value. While improving the appearance of the switchboard, however, they performed a far more important service. If, owing to trouble on the line, the circuit-breakers on the generators opened, the lights from the ammeter dials were sufficient to enable the operator to handle the switchboard.



FIGS. 3 AND 4. SHOWING AMMETER-LAMP AND GROUND-LAMP CONNECTIONS

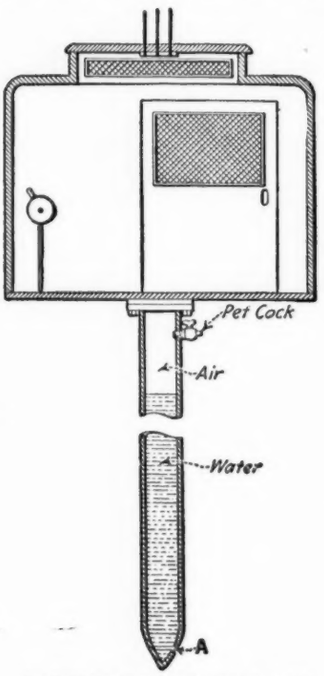
Another addition to the board which soon proved its worth was ground lamps. Four 120-volt lamps were connected in series across the 220-volt bus with a ground wire connected so as to put two lamps in series with the ground on each side of the circuit. The four lamps being connected in series across the two busbars burned on half voltage. A ground on the system would cause one pair of lamps to go out, while the other would light up to full brilliancy, the ground being on the side of the circuit to which the dark lamps were connected.

I might add that the voltmeter was arranged so that by means of a switch the intensity of the ground on either side of the system could be measured. While the voltmeter method of testing for ground is very desirable, especially in locating slight grounds in motors, lamps, canopies, sockets, etc., bad grounds, which it is so desirable to discover before they do serious damage, are instantaneously called to the attention of the switchboard operator by the action of the ground lamp. For the best results both systems of detecting grounds are necessary on a switchboard.

New York City. WARREN D. LEWIS.

Hole in Plunger Caused Elevator Trouble

A private residence was equipped with a hydraulic elevator. When the lady of the house, who weighed over 200 lb., entered the car, the elevator would sink about 6 in., and when she got off it jumped up an equal distance. This got on her nerves and she sent a hurry call to the city for an elevator man.



PARTLY FILLED PLUNGER

This man and his helper spent all day putting in new cup packings and packing plunger glands, but the elevator acted just as badly as before. The foreman of the shop was sent for, but he could not locate the trouble. Finally, it was discovered that air was the cause, owing to the fact that a hole had developed at the bottom of the plunger, as shown at *A*, due to corrosion. As a result, the plunger partly filled with water and the air in the upper part acted as a cushion. A ¼-in. hole was drilled and tapped for a pet-cock, as shown. This did the trick until a new bottom section was secured and put in place.

Springfield, Mass. THOMAS SHEEHAN.

Owners Should Supply Instruments

I see, in the July 15 issue of *Power*, page 116, that J. B. Tait is of the opinion that owners of power plants should supply all instruments used which tend to improve the economy of the plant. Candidly, I am of the same opinion, for in many cases the engineer receives but little thanks for improved economy and there is no immediate return for the money expanded for such instruments.

At one time I was operating an automatic engine running 115 r.p.m. This engine required all the steam that three 150-hp. gas-fired boilers could make. After being there for three weeks I put on the indicator and obtained a few diagrams, and the following Sunday I opened the steam chest to see what was wrong and found that there was about $\frac{1}{16}$ in. between the face of the valve and the pressure plate. After adjusting things we found that two boilers would carry the load and a saving of $7 per day was made in the gas bill, but not a cent raise in salary.

At another time we had a throttling slide-valve engine, directly coupled to an ice machine, the speed being 75 r.p.m. The compression was low and the cutoff was a little past ¾ stroke, so a ⅜-in. strip was added to the steam lap, which brought the cutoff to a little less than half-stroke. After this change, we could see a difference in the coal fired to the boiler.

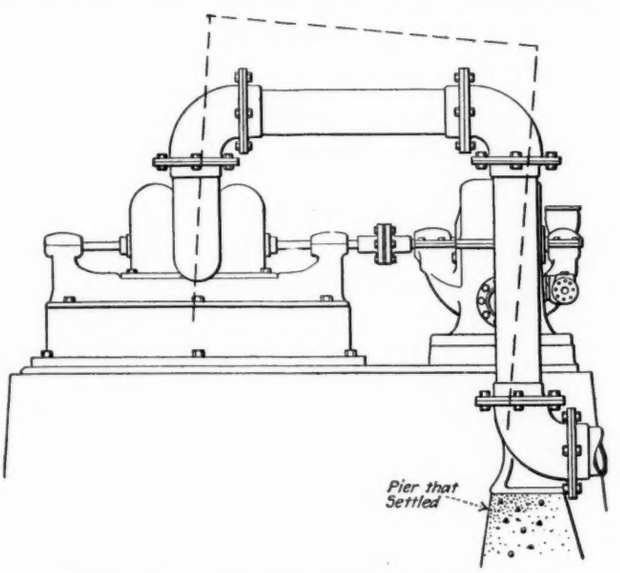
At one time I bought a hand CO_2 instrument costing $40. As I wished to learn its use, and after reading the instructions thoroughly, I tried it out on a 150-hp. return-tubular boiler and found an average CO_2 of 6 per cent. I asked the firemen to change his method of firing, and he began to take some interest in the proceeding. We obtained 12 to 14 per cent. CO_2 and a stack temperature of 475 to 500 deg. F., but the owner or manager took no interest at all and I came to the conclusion I would sell the instrument, which I did. Then and there I said never would I buy another instrument to increase economy and benefit the other fellow. I concluded that if they have not enough interest in the economy of their own plant to furnish any and all instruments, I would do my best with what I had. However, I will always keep an indicator.

Columbus, Ohio. A. L. COWLES.

Shaft Alignment

W. A. London's letter, under the caption "Shaft Alignment" on page 351 of the Aug. 26 issue, is worthy of notice. It has been my experience to have more or less pumping machinery operated through the flexible coupling.

Not long ago one of my associates asked the questions: "Why introduce a flexible coupling between the steam turbine and centrifugal pump? Why not eliminate one bearing, as we do in the motor-exciter set?" Shortly after he was shown in rather a forcible way the value of couplings. A pier settled under the discharge pipe of the pump (see illustration), and the distortion was



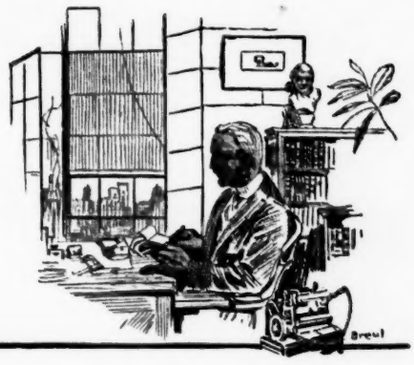
DOTTED LINE SHOWS TENDENCY OF PIPE POSITION WHEN PIER SETTLED

sufficient to cause the rubber bumper in the coupling to go to pieces, but the bearing was not injured.

The baseplate of the ordinary unit of this kind is more or less easily warped, and it seems to me that all installations of this type should be equipped with flexible piping joints as well as flexible shaft couplings. For one I would never ask for three bearings; four bearings with the flexible unit between the two center bearings is a good mechanical combination. Many pump builders equip their apparatus with the prime mover specified by the purchaser, and it would be rather a delicate proposition to leave out a bearing.

New York City. C. W. PETERS.

INQUIRIES OF GENERAL INTEREST



Reason for Lap of Corliss Steam Valves—Why is lap given to the steam valves of a single-eccentric Corliss engine? H. L.

To obtain early release after expansion and compression of the exhaust, it is necessary to advance the eccentric ahead of the 90-deg. position. With the eccentric advanced, all the valve events occur earlier in the stroke and, when the wristplate is in its central position, the steam valves must have sufficient lap to be closed long enough to prevent excessive lead.

Carbon Mineral or Mined Coal—We have an inquiry from a Central American customer for a boiler that is to be provided with grate suitable for burning "mineral coal." What particular kind of fuel is referred to? S. H.

In Spanish-American countries, extensive use is made of charcoal (carbon de leña) and your correspondent intends to confine consideration to mined coal, for which the Spanish technical designation is "carbon mineral" and the common designation is "carbón de piedra," or stone coal. The inquiry undoubtedly refers to use of a low grade of bituminous coal.

Rating of Alternating-Current Generators—What is the kilowatt rating of a 550-volt 300-amperes three-phase alternator at 0.80 power factor? What would be the machine's kilowatt rating at unity power factor? H. A. L.

At unity power factor the alternator would have a kilowatt rating equal to volts × amperes × 1.732 × power factor ÷ 1000 = 550 × 300 × 1.732 × 1 ÷ 1000 = 285.78. This means that this machine when operated at unity power factor can supply a load of 286.78 kw. At 0.80 power factor the kilowatt rating = 550 × 300 × 1.732 × 0.80 ÷ 1000 = 228.62; that is, at 80 per cent. power factor the alternator can supply only a 228.62 kilowatts load.

Hp. Constant and Required M. E. P.—What is the horsepower constant of an 18-in. × 48-in. engine running 74 r.p.m., and what would be mean effective pressure for development of 375 indicated horsepower? R. W. R.

The horsepower constant, or power developed per pound of mean effective pressure, is found by the usual formula,

$$Hp. = \frac{PLAN}{33{,}000}$$

assuming $P = 1$; L = length of stroke in feet; A = area of piston; and N = the number of single of strokes. Hence, for the conditions

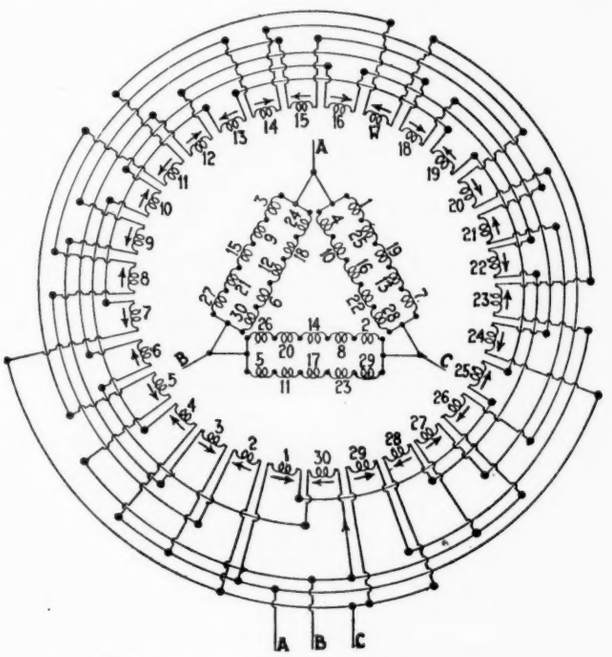
$$Hp.\ constant = \frac{1 \times \frac{48}{12} \times (18 \times 18 \times 0.7854) \times 74 \times 2}{33000} = 4.565.$$

Development of 375 i. hp. would require 375 ÷ 4.565 = 82.15 lb. m. e. p.

Reconnecting Synchronous Motor—We have a 6600-volt, three-phase, 60-cycle 720-r.p.m. synchronous motor connected one circuit "Y." The machine has 60 slots in the stator; two slots per pole per phase. We would like to reconnect this motor so as to operate on a 2200-volt circuit at 720 r.p.m. How should the windings be connected? W. H. K.

The machine as it is now connected has 10 poles; 2200 volts, is one-third of 6600, therefore the winding should be reconnected, for 2200 volts, so as to give one-third the number of turns in series in the 6600-volt winding, or 3-parallel star. However, the connection cannot be obtained since the machine has 10 poles, and 10 is not divisible by 3. The only other connection that can be made which offers a possibility of satisfactory operation is a 2-parallel delta, as in the figure; but this is good for only $\frac{6600}{2 \times 1.732} = 1905$ volts. With the winding connected 2-parallel delta and operating 2200 volts, it will be working at $\frac{2200 \times 100}{1905} - 100 = 15$ per cent. overvoltage

This overvoltage would in general be excessive, therefore it is advisable to take up with the manufacturer the question as



TEN-POLE TWO-PARALLEL DELTA CONNECTION

to the advisability of subjecting the motor to this overvoltage. The full pitch of the winding would be 6 slots; that is, the coils would be wound in slots 1 and 7. If the coils happened to be wound in slots 1 and 6, the cord factor would be 0.95. Increasing the pitch of the winding to 1 to 7, or full pitch, would make it suitable for operation on $\frac{1905}{0.95} = 2005$ volts, or the motor would then be operating at 10.7 per cent. overvoltage. If this condition can be met, there is little doubt that the motor will operate on 2200 volts.

Excerpts From Elevator Regulations, State of Massachusetts

By EDWARD A. SMITH

Mechanical Engineer, Otis Elevator Co., New York, N. Y.

EXCERPTS from the elevator laws of the State of Massachusetts for power-driven passenger, freight and sidewalk elevators. Effective June 19, 1914, revised June 19, 1915. For all elevators in the state except Boston and United States Government installations. The excerpts are from the laws pertaining to both existing and future installations. Where the law is for future installations only, it is not quoted except where noted.

Current: Passenger, Freight and Sidewalk—Existing and future, 250 volts maximum allowed at car switch on push-button.

Safeties and Governors: Passenger—Future installations require gradual-stop type of safeties with governor for speeds over 100 ft. per min. Speed 100 ft. per min. or less, either gradual with governor or instantaneous, rail-type, with governor, or broken-rope spring-grip type. For vertical-hydraulic machines rising over 15 ft., either gradual or instantaneous with governor 100 ft. per min. or less; rise 15 ft. or less, no safety required. Existing counterweight to have safeties if counterweight does not run down to bottom and space below is used. Safeties on all passenger elevators to be below car bottom. Existing installations same as above except instantaneous, with governor permitted for all speeds and safety may be in crosshead. Freight—Same as passenger, existing and future, belt- or chain-driven elevators, 100 ft. per min. or less, rise over 40 ft. permitted. Must have safeties either gradual or instantaneous with governor; under 40 ft. rise broken-rope type of safety permitted. Carriage-type and hatchway-type require no safeties.

Car Enclosures and Platforms

Car Enclosure, Platform and Slings: Passenger—Existing and future installations, wood or metal solid or open 2-in. mesh. Future only, all unused sides and top. If open mesh is over ⅜-in., use ⅜-in. mesh, No. 20 wire screen over counterweight, if clearance is less than 6 in. and sides if clearance is less than 4 in. Not more than two openings permitted; ¾ in. clearance between car and sill, 1½ in. maximum; 1 in. minimum between car and counterweight; ¾ in. minimum between car and shaft. Gates with contacts required if car has two openings. No contacts on existing elevator if operator can protect opening. If car has no licensed operator, gates to be furnished on cars with contacts or interlocks and contacts on shaft doors of electric elevators. Car domes to be cut back or hinged with brass, bronze or composition hinges, 15 in. back from sill, if either no gate is furnished or no interlock on shaft doors. Above can act as emergency exit. Not more than one compartment permitted, except in existing elevators, and must have car gates or doors with contacts or interlocks on shaft doors. Freight—If mesh of car enclosure is larger than ⅜ in., use ⅜-in. mesh No. 20 wire screen over counterweight; if clearance is less than 4 in., inclosure must be 6 ft. 6 in. high on all unused sides or to crosshead if lower. Warning chains 30 in. long, 6 in. centers, required. No enclosure required on carriage-type elevator. Tops required, except for hatchway-type and carriage-type or where semiautomatic gates extend to floors, all floors above lowest or where doors are furnished at all floors locked from shaft side and kept closed. Top to be of 1½-in. x 3-in. mesh No. 9 gage wire or equivalent strength, cut back not over 6 in. from sill at landings and hinged not less than 18 in. No emergency exit required. If existing or future freight cars carry more than two persons and operator, they must be enclosed on all sides, except a 42-in. or less door opening or equipped with car gates or doors. Portable enclosure or gates permitted if freight car is used stated hours for passenger service. No auxiliary department permitted except for existing elevator (see passenger). Openings in car enclosure permitted for hand-rope. Car or shaft to be lighted except hatchway-type and carriage-type to have light at each floor near elevator or in shaft if solid enclosure. Sidewalk—Must have light at each floor near elevator or in hatchway if solid enclosure.

Control: Passenger, Freight and Sidewalk—Switch (push-button allowed in private houses, apartment houses and private offices), wheel or lever, 150 ft. per min. maximum (future only) except hydraulic elevator. Direct-connected traction exceeding 200 ft. per min., switch required, to have two speeds. Hand-rope 150 ft. per min. maximum, centering ropes to be provided except sidewalk.

Hatchway Gates: Passenger—Not permitted. Freight—Gates may be full-automatic gravity-drop, semiautomatic or gravity, of metal or hardwood strength of ash, joints to have metal plates. Gate shoes and runs on operating sides to be of metal. Bar gates hinged at one end to have accurate and rigid support when closed. Gates not required where shaft doors are arranged to be opened from shaft side except by key from outside and a licensed operator on car. Collapsing gates where there is danger from shear not permitted. Semi-automatic Peelle-type gates or doors not permitted unless arranged to open from shaft side only and regular operator on car. Double-blade gates permitted if solid or ⅜-in. mesh and no danger from shear. Existing gate 4 ft. high or higher if practicable. Top-story gate need be only 3 ft. 4 in. high. Gates to have locks that cannot be opened from outside and are opened by car. Above does not apply if landing is on a bridge, above ground and not public. Above also applies to ground openings, elevators located outside building. Sidewalk—Gates not required at bottom landing where elevator serves only two adjacent floors, but must have hand operated bar, gate or chain.

Ropes for Passenger Elevators

Ropes: Passenger—Iron or steel (marlin-covered prohibited for passenger service). Each steel cable tagged "Steel Cable" on metal plate 1 in. minimum diameter, above shackle. Two hoisting cables each to car and counterweight. One counterweight cable permitted to remain on existing installations. One full turn on drum for car and counterweight when at limit of travel. Drum ends secured by clamps or tapered sockets. Governor ropes to be steel for speeds over 100 ft. per min., hemp 100 ft. per min. or under. Shipper ropes to be inaccessible from landing openings in outside walls. Shipper ropes to be insulated if necessary. Freight—Same as passenger. One rope permitted on counterweight if 1400 lb. or less. One lift and one counterweight cable permitted to remain on existing installations and not carrying more than three persons. Sidewalk—Same as freight. Chains permitted.

Grating: Passenger—Platform under machine and sheaves to sustain lead of 50 lb. per sq. ft.; wood, solid 3-in. plank, existing plank may remain if it sustains 50 lb. per sq. ft. Grating 1½-in. centers covered with ⅜-in. square No. 20 gage wire netting. If hatch has over 50 sq. ft. area, platform 2 ft. beyond machine and sheaves, with baseboard 6 in. high is required. If space between platform and wall exceeds 12 in., hand-rail 2 ft. 6 in. above platform required. Access permitted from top of car. Existing hatch ladder from top floor to opening in grating permitted for emergency. Freight—Same as passenger except not required on existing and future hatchway-type or carriage-type elevators.

Counterweight Screens: Passenger—No top screen required. Bottom screen solid metal or screen ½-in. mesh 6 ft. 6 in. high, bottom or screen 6 in. above pit, except where compensating chains would interfere, or except where counterweight bumpers are 5 ft. or more high. Counterweights in isolated shaftways inclose full height with fire-resisting construction or No. 16 gage steel, with removable section 2 ft. from top, except outside building enclosure only 7 ft. high required. Open existing enclosure may be covered with ⅜-in. mesh No. 20 gage. Freight—Same as passenger, except existing and future hatchway-type elevator counterweights, which shall be boxed

in from bottom of pit full height to as close to sheave as possible and top covered except for ropes, with removable section 2 ft. from top or to clear hatchway door when open.

Stop Motions and Shaft Limits: Passenger and Freight—Power-driven elevators (except traction and plunger type) rise 30 ft. or less, speed 150 ft. per min. or less) to have machine limits set to stop car or counterweight before 18 in. above normal travel, or one-half of run-by when less than 3 ft. Chocker-valves on hydraulic machines are considered as machine limits and on existing operating valves automatically closed by machine independent of shipper rope. No chain- or rope-driven stop motion except in addition to regular machine stop motion permitted on drum machines. Switch or push-button controlled elevators to have shaft limits, operated by car and counterweight and to stop machine before 18 in. above normal travel, or one-half of run-by if less than 3 ft. Two- or three-phase electric machines to have shaft limits in addition to machine limits. Hand-rope control to have stop balls to stop cars not to exceed 6 in. above top and below bottom floors. Sidewalk—Machine limits if drum machine and stop balls on rope of all machines.

Interlocks Required on Swing Doors

Interlocks: Passenger—Swing doors must have interlocks or contacts; push-button or dual (push-button and switch) control to have standard push-button interlocks. Shipper ropes that are accessible from landings doors to have interlocks or contacts. All doors in outside walls to have interlocks. Existing elevators with compartments must have contacts on car gates or doors or interlocks on shaft doors. Car gates away from operator to have contacts. Elevators without licensed operator to have contact on car gate or door. Freight—Push-button or dual control (push-button and switch) to have standard push-button interlocks. Gates and doors in outside walls to have interlocks. Existing elevators with compartments must have contacts on car gates or doors or interlocks on shaft doors. Sidewalk—No interlocks required serving two floors only; if more than two floors, same as freight.

Emergency Switches: Passenger—Emergency switch or stop-button in all switch or push-button control elevators to control main-line circuit in cable independent of car control. Slack-cable device required on all drum machines over 15 ft. rise. Elevators to have annunciator or other signal system operating from each landing except in private residences or cars with no licensed operator. Freight—Same as passenger except no slack-cable device required on carriage type or on existing freight machines located above top landing and carrying not over three persons. Centering ropes required on hand-rope operations. If signal system is not furnished, a bell must be furnished in shaft which can be heard from and operated from all floors. Not required for two stories only. Gong required with sliding hatch covers; not required with hinged covers.

Rope Locks: Passenger—Not required, but permitted. Freight—Rope lock required.

Hatchway Enclosures: Passenger—Future installations, enclosed full height with brick, terra cotta, wire lath and plaster, wired glass set in metal frames or other fire-resisting construction. Thickness of wall, wire glass to conform to local city regulations if any. Sash stationary except in outer wall and frames, and sash may be of wood, plate glass if local laws permit. Exterior windows to have ⅝-in. vertical metal bars on outside 10-in. center and painted. Fireproof enclosure not required within wellways of surrounding stairs. Fireproof enclosure not required for elevators outside of building. Solid or 2-in. grille 7 ft. high above grade. Fire proof enclosure not required for hatchway type. Enclosure 3 ft. 4 in. high except on landing sides with grille sheathing, wood or metal double-rail fence except where there is 2 ft. or more clearance above vertical lift covers for top floor. If future hatchway pierces one floor only, one story to be of fireproof material and full height, other floor metal, grille or equivalent 2-in. mesh 7 ft. high, and if on lower floor full height at openings, except outside building or in stair-wells. Where grille is used larger than ⅜-in. sq. mesh to be covered 6 ft. 6 in. high ⅜-in. sq. mesh No. 20 gage wire only, where there is less than 4 in. between grille and sliding door. Sills projecting 1 in. or more to be beveled on underside 60 deg. with horizontal.

Existing Installations: Enclosures for hatchway type same as future; enclosures for outside building same as future; all other enclosures at each floor except at landing to be 7 ft. high solid or 2-in. grille, to be covered same as future if mesh is larger than ⅜-in. square. Freight—Same as passenger except future elevators and piercing one floor only if top floor is fireproof; bottom floor may be grille, sheathing, wood or metal double-rail fence 3 ft. 4 in. high. Carriage type piercing one floor only, enclosure 3 ft. 6 in. high grille, sheathing, wood or metal double-rail fence. Carriage type rising more than two floors, fireproof full height above second floor. Existing and future, windows and recesses to be made flush with vertical bars or slats 3 in. x ⅞ in., or pipes not over 4 in. apart. Not to be furnished if semi-automatic gates or gates with contacts are furnished on car, or car is enclosed on window side. If above bars are furnished, ⅝-in. iron bars 10 in. centers on outside all exterior windows required. Sidewalk—No enclosure required except at sidewalk level; public passageway to be protected by wood or pipe guard 18 in. high before elevator is started. If manually operated doors, the doors with rod to act as guard.

Enclosure Not Required in Engine Room

Motor-room Enclosure: Passenger and Freight—Located on floor, to be enclosed solid or 2-in. grille 4 ft. high. If located in engine or pump room, no enclosure required. Free and safe access to be provided to all parts of machine. Penthouse door to be furnished.

Licensed Operator: Licensed operator required for passenger, except push-button type, or where shipper rope accessible from landing; or elevator serving two landings and doors equipped with push-button interlocks; or elevator in private house (one family). Freight—Licensed operator required where car runs over 100 ft. per min. or carrying four persons including operator, or where no landing gates are provided except for elevators serving two landings. License application made on blanks, person over 18 years old, on recommendation to local authorities by owner, occupant or lessee or by two persons, term one year. Fee $1; renewal, 50c. Operator to carry license on person. In emergency a competent unlicensed person permitted for seven consecutive days. If elevator not requiring licensed operator is not being operated with regard to safety, inspector will appoint designated operator or operators. Designated operators for permanent elevators in unfinished buildings.

Belt or Main Drive Prohibited

Hydraulic Tanks, Valves, Cylinders: Pressure tanks to have dials or gages graduated to not less than 1½ times maximum pressure, and connected to tank with brass pipe and with cock with T or lever handle near gage. Also water-glass gage connection with brass pipe. No cast-iron or flat-stayed heads allowed. Tanks to be provided with ¼-in. pipe to attach inspector's gage. Tanks to be supported so they can be inspected all sides and ends. Pump to have water-relief valve. Relief valves to be set to discharge at safe working pressure of tank and cannot be shut off. Relief valves may be piped to discharge tank or pump suction. Steam pumps to have pressure regulators. Electric pumps to have automatic pressure regulators to control motor or automatic bypasses. Vertical hydraulic sheave straps to be two-part steel or iron hangers, no U-straps allowed.

Installations Prohibited: Belt or chaindriven machines not permitted for passenger service. Means must be provided for throwing the power off a belt or chaindriven machine, if machine is not driven by separate motor. Elevator belts within 7 ft. from floor to be properly guarded. Friction gearing or clutch mechanism prohibited on any machine where a person is carried.

Repairs and Alterations: An existing installation moved to a new location will be considered a new installation, also an existing installation that is materially changed. Any changes other than ordinary repairs are material changes. New parts furnished must comply to rules for new installations, but machine or ropes can be changed without changing car, shaft enclosure, gates, doors, etc. If platform is attached to existing hoisting mechanism not previously equipped with platform, it will become a new installation.

International Power Economy Conference

On Oct. 30 and 31 the International Power Economy Conference, an association of manufacturers of power-plant products, held its second meeting in the rooms of the Western Society of Engineers, Chicago. Nearly a year ago the movement had been instigated by C. A. Tupper to promote power-plant efficiency and fuel conservation by perpetuating the work started by the Fuel Administration during the war. An executive committee had been appointed and eventually nineteen other committees representative of the various phases of power-plant economy. There were committees on combustion, fuels, engines, turbines, boiler settings, insulation, instruments, lubrication, coal and ash handling, etc. These committees were to analyze the relation of the various apparatus and appliances to the general subject and report in a tentative way as to the part each might play in coördinating the efforts to bring about a greater appreciation, of the advantages resulting from intelligent use of the apparatus or product in question.

At the meeting the chairmen of most of these committees presented brief reports, but the primary object of the present gathering was to decide more definitely what was to be done and how to do it. The following report of a committee appointed for the purpose will give explicitly the objects and the method of procedure:

Disinterested public service in the subject of conservation of fuel resources.

We are initiating this movement because of our direct understanding of conditions and desire to convert to the public good our specialized knowledge of this subject.

We, having had direct and intimate acquaintance with the work and results of the Fuel Administration during the war, believe that the results accomplished were substantial and in the interest of the public at large, and we, the International Power Economy Conference, advocate the continuance of the work of the Administration through the Bureau of Mines, or suitable Government agency.

We are convinced that the losses are so widespread and ingrained that only Governmental action will result in securing effective improvement.

Serious waste occurs in mining, preparation, transportation and utilization of fuel, much of which is preventable. If prevented, a saving to the public will be made of $500,000,000 annually.

We, therefore, unite for the purpose of bringing about the results stated in the preamble by means of the dissemination of information on this subject, which should lead to an awakening of public interest and create a demand by the public for Governmental action. In furtherance of this subject, we solicit the coöperation of the public as well as all civic and engineering bodies, and pledge ourselves to collect and distribute data on this subject as to the best means of accomplishing the economies sought.

Resolved: That the Conference shall become an incorporated association with the usual officers and directors as soon as 100 representative firms shall become contributing members.

There shall be appointed by the chairman an executive committee of ten, which shall conduct the campaign for membership and draw up a constitution and by-laws for presentation to the next conference.

Upon the election of the permanent officers, the executive committee shall be dissolved.

The permanent officers and directors shall thereafter direct the affairs of the association as is usual in accordance with the constitution and bylaws adopted by the conference.

The preceding report was accepted with enthusiasm and further procedure will be based on its contents. It was realized that Government supervision of mining, transportation and efficient utilization of fuel in the power plant would not be possible without an ample appropriation from the Congress and the passage of a bill authorizing the Bureau of Mines to conduct the work. An extended educational program would first be necessary to create public sentiment and bring it to bear for such action. The campaign would be of such a nature as to acquaint the coal-using public with the possibilities of conservation and saving in the power plant. It was to be triple-barreled, reaching the management, the engineering department and the men operating the equipment. Aid would be sought from civic bodies, such as chambers of commerce, and from engineering societies, particularly that of the four great founder societies through the consulting engineers committee advisory to the Bureau of Mines, which has been made a permanent organization.

The committees were to be retained and each was to be representative of all manufacturers in that particular branch. The executive committee would call on these branch committees for authentic information telling the public of the savings that were possible and how the product should be utilized to secure maximum economy. These men were experts in their particular line, had the information and were in a better position, possibly, than anyone else to give out such desirable data. It was realized that commercialism must not be allowed to creep in, and one of the functions of the executive committee would be to eliminate any tendencies of this character.

The first efforts, then, of the new association are to be an educational program showing up the possibilities of conservation and the influence the various products manufactured will have on efficiency. In time it is hoped that this information will create sufficient public sentiment to insure through the Congress, Federal supervision.

As to methods to be followed in this supervision no definite program was outlined, but David Moffatt Myers, former consulting engineer to the Fuel Administration, was present and gave from his previous experience a summary of what he considered essential. By careful Governmental regulation it was his belief that fully 100 million tons of coal, amounting at an average figure of $6 per ton, to $600,000,000, could be saved, where an annual appropriation of perhaps $1,000,000 would cover the expense of this regulation.

He considered the Bureau of Mines as the most authoritative source of information in the country on fuels and their conservation. The Geological Survey had made careful study and survey of the possibilities of extending the use of water power. These two branches of the service are coördinated under the Secretary of the Interior and are the logical means of handling the problem from headquarters in Washington. A salaried engineer should be appointed by the Department of the Interior to hold office in each state and report to Washington to keep the central bureau of conservation informed on local conditions. The state engineers would keep in touch with industrial developments in their respective territories, interest themselves in the problems involving conservation and bring about the closest touch between local industries and the clearing house of information in Washington.

As an additional and essential feature an advisory body of engineers would assist materially in keeping the Bureau in close touch with the problems and developments of the country and would assist in recommending policies for the Bureau.

By the proposed organization encouragement should be given to new developments leading to economical use of fuel for power generation and for other purposes; such, for example, as the recovering and utilization of the byproducts of coal resulting from low-temperature distillation. No raw coal should be burned under boilers.

Five Engineering Societies Have Amalgamated With A. A. E.

Action by the 300 members of the 25-year-old Engineers and Architects' Association of Southern California, Oct. 25, in becoming the Los Angeles chapter of the American Association of Engineers, although it retains its name, marks the fifth organization that has taken this step within a few months. The Oregon Society of Engineers, a state society, amalgamated with the Portland chapter to form the Oregon Chapter of A. A. E.; the Houston Engineers' Club became the Houston chapter; the Navy Technical Association was taken over and split up, members in New York, Philadelphia and other seaports becoming sections of the local chapters. One of the late developments is the Southwest district, into which the Southwestern Society of Engineers has been formed. Eventually there will be several chapters in this district. The district will cover West Texas, New Mexico and Arizona. The old organization was a low fee one-or-two-meeting-per-year society, but since the dues have been raised and new welfare work has been taken on, the membership has grown from about 175 to more than 400. All of the above organizations have become part and parcel of the A. A. E., not simply affiliated with it, as is the arrangement local chapters have with the Associated Engineering Societies of St. Louis and with the Cleveland Engineering Society.

The Purchase of Coal on Specification

ON Nov. 17 at a joint meeting of the Mechanical Engineering Section of the Western Society of Engineers and the Illinois Chapter of the American Society of Heating and Ventilating Engineers, the above topic was discussed from the standpoint of the purchaser and from the position of the coal operator. John Howatt, chief engineer, Chicago Board of Education, and president of the Illinois Chapter of the American Society of Heating and Ventilating Engineers, took the purchasers' viewpoint, and Edward H. Taylor of the Crerar Clinch Coal Company spoke for the operators.

In the primary paper of the evening Mr. Howatt reviewed the various forms of specifications used in the purchase of coal. Due to the expense involved in the checking up of complicated specifications the user of small quantities of coal is forced to buy his fuel on a general specification as to size and grade only. This method of purchasing coal is all in favor of the coal dealer, and under normal conditions should never be resorted to by corporations or institutions that purchase coal in sufficient quantities to warrant the expense of checking and testing deliveries. Years ago specifications of different forms were prepared and put into use, the more common being the specification and award of contract for coal on a guarantee of coal of a definite size from a definite specified mine. This form of purchase is still used extensively, but is open to the objection that in case of accident or shutdown of the particular mine, the purchaser is forced on the open market without protection. Furthermore, it is almost impossible to check the origin of all deliveries, especially if they be made by wagon to many points, so that a poor grade of coal might easily be substituted in some of the deliveries.

At one time attempts were made to purchase and pay for coal on evaporative tests. The bidder that agreed to evaporate the greatest number of pounds of water per pound of coal as received being awarded the contract. It was presumed that the contractor would deliver coal of the same quality as the sample furnished for test throughout the life of the contract. The method proved cumbersome, loose and possible of uncertain results, and in practice it was found difficult to prove the quality of the coal, based upon such tests when controversy arose.

This type of specification has been largely superseded among purchasers of large quantities of coal by a specification in which the purchase is based upon the chemical analysis and heat value of the coal itself. This method is less cumbersome, more scientific and exact and enables a check of results. It is the one method that can be used to compare results of coal of all kinds under boilers in any location. In 1907 the Government started to purchase its coal on this basis, abandoned the method during the war, and again put it into effect last July. Many states, cities and public institutions followed the Government in adopting the B. t. u. method of purchasing their coal supply, varying somewhat in details and methods, but all taking into consideration the quality as well as the quantity of the coal. The cost of coal has risen so much that it is more essential than ever that the purchaser should buy it in accordance with its value to him as a steam maker.

Before making any attempt to prepare a specification for coal, the consumer should try out coals of different sizes and from different coal fields in his boiler plant, and thus obtain information as to what size of coal will give the best results, and from what fields the coal can be used successfully in his furnaces. If analyses of each coal tried are obtained, the consumer will then be prepared to specify the size of coal desired and place limits for ash, moisture and heat value, as the basis of a scientific specification for future purchases on the B. t. u. method. If the coal is specified further to be free of excessive clinkering and to be free burning, the purchaser should be in a position to place contracts for coal not necessarily on the lowest price per ton as bid, but the lowest cost to him for the year's fuel supply. Weak draft or insufficient boiler capacity may of course make it desirable to purchase the highest grade coal regardless of the fact that the price per unit of heat value may be higher.

Taking it for granted that all the coals considered in making a selection are free burning and free from excessive clinkering, there are but three things the purchaser of bituminous coal needs to know; they are its ash content, its moisture content and the heat value or B. t. u. per pound. All formula used in specifications covering the purchase of bituminous coal on the heat value basis should contain these three factors, the first two being loss factors and the last a credit factor on each pound of coal.

The purchaser must bear in mind that the ash content in coal is of considerable importance to him, as he must pay for it at the same rate that he buys the coal, and is subject to the cost of its removal after the coal is burned. Ash naturally reduces the heat value of the coal, and in practice there is a further loss when the ash percentage exceeds a certain limit by reason of the drop in capacity and efficiency of the furnace by the ash deposit clogging the fires. Consequently in the specifications a maximum limit on the percentage of ash should be made, and a penalty for the ash content in coal over the maximum should be provided heavy enough to prevent very much coal of this character being furnished. The penalty should be on a scale that increases rapidly as the percentage of ash increases, and if the ash content is lower than the limit named in the specifications, the contractor should obtain an increased price per ton corresponding to the increased value of the coal.

As a guide for price adjustment to take care of the ash content reference was made to the two typical methods representing latest practice used by the Government and by the city of Chicago. In the Government specifications a standard ash value on a dry basis for the quality of coal it is intended to purchase, is established. Deductions are made from the price to be paid for the coal on a rapidly ascending scale where the ash content is more than 2 per cent. in excess of that named as standard, and a bonus is allowed to the contractor when the per cent. of ash is less than the standard. In the Chicago specification a reduction is made for all the ash in the coal instead of only that in excess of the limits. In this regard it is more scientific, but not as practicable in application at the present time.

Formulæ used in purchasing coal on a B. t. u. basis as a rule make no penalty for moisture other than that provided by reducing the coal delivered to a dry basis. The Government specifications provide for a payment based upon the B. t. u. in the coal as received. The B. t. u. per pound of coal will thus be reduced automatically in proportion to the amount of moisture in it. The city of Chicago specifications provide for payment upon the B. t. u. in the dry coal, but reduces the amount of coal paid for by the amount of moisture in it. The resultant number of heat units in a ton of coal and the price paid the contractor from either specification are therefore identical.

As the B. t. u. per pound varies as much as 30 per cent. between the different commercial Illinois coals, it may be seen that the purchaser can secure what he pays for in heat value only through a method of purchase that bases payment on the B. t. u. per pound of coal. This is the most important factor in all coal purchases made upon analysis.

In writing proposals for coal to be purchased, limits for B. t. u. per pound should be named far enough apart so there will be plenty of opportunity for competitive bidding and still limiting the coal to the general quality desired. The speaker told how the Government and the city of Chicago compared bids on this basis and gave the formulæ by which the price of the coal was determined.

Securing of representative samples for analysis the speaker admitted was the most difficult part of the entire operation when buying coal on the B. t. u. basis. Rules had been established governing the taking of samples which were explicit enough and if strictly followed would result in fair samples being taken; yet it was easy for the sampler to be careless or even dishonest with results in favor of either contractor or purchaser. A careful selection of samplers of intelligence and unquestionable integrity was the best safeguard for both parties. For explicit directions in taking samples that would be representative of the entire lot of coal, reference was

made to technical paper No. 133, published by the Bureau of Mines and prepared by George S. Pope.

To guard against failure of the contractor in complying with specifications, the contract should be specific on what conditions the purchaser has the right to reject a delivery of coal, and under what conditions there may be a forfeiture of the contract. The specifications also should provide under what conditions the purchaser has the right to obtain coal from another dealer and charge the difference in cost, if any, against the contractor's account. No institution should place its contract for coal with a concern that has previously failed to meet its obligations, or has not the means or facilities to properly carry out the contract under adverse circumstances.

The writer had nearly ten years' experience in the purchase of coal, and had made purchases on all the different methods. Based upon his experience he was convinced that public institutions at least should purchase their coal on the B. t. u. basis, as had been outlined, until some better scientific method was developed that would provide protection for both buyer and seller. The advantages could not be summarized better than in the six paragraphs of the Bureau of Mines Bulletin No. 41, which follow verbatim:

1. Bidders are placed on a strictly competitive basis as regards quality as well as price. This simplifies the selection of the most desirable bid and minimizes controversy and criticism in making awards.

2. The field for the purchaser and the seller is broadened, as trade names are ignored and comparatively unknown coals offered by responsible bidders may be accepted without detriment.

3. The purchaser is insured against the delivery of poor and dirty coal and is saved from disputes arising from condemnation based on visual inspection.

4. It is not always expedient to reject poor coal because of difficulty, delay and cost of removal. On the B. t. u. system rejectable coal may be accepted at a reduced price.

5. A definite basis for the cancellation of the contract is provided.

6. Being paid for on the penalty basis incites the contractor to prepare coal more carefully.

Speaking for the coal operators and distributors, Mr. Taylor gave the following objections to heat value specifications in coal contracts:

1. That the contracts as drawn are not mutual.

2. That the terms of settlement are based on the assumption that all samples taken are truly representative of the quality of the coal delivered. This the coal operators contend is not a fact.

3. That the contracts so operate that deductions made for the delivery of coal below contract grade is greater than the loss actually sustained, making such deductions, therefore, a penalty instead of liquidated damages.

4. Heat value specifications offer an opportunity for graft and shakedowns on the part of the buyer's representative, and the same opportunity for bribery and trickery on the part of the contractor.

5. Such a contract promotes and fosters unfair competition which works to the detriment of both the buyer and the contractor.

From the various experiences of the operators, numerous cases were cited to make clear their reasons for the objections given. Taking samples that were truly representative of the quality of the coal delivered was the great bugbear, and in addition there were few laboratories properly equipped with instruments standardized to insure accuracy. The coal operator had no redress, as the testing was in the hands of the buyer and testing of the coal by third parties would add considerably to the price of the fuel. What was needed was a closer relationship and more confidence between the buyer and the contractor. The latter fully realized the value of the proximate analysis, as he used it himself when sinking a mine to decide whether the coal was of such quality as to be worth mining. The contractor also believed that the proximate analysis was valuable for identification, as he used it for that purpose, and was of the opinion that proximate analysis and sample taking were sufficiently accurate for this work.

It was the contractor's belief that the buyer should select the coal best suited for his needs after having tested it in his plant to his own satisfaction, and then ask for bids on the grade of coal desired—not for bids on any kind of coal. The Retail Coal Merchants' Association of Chicago was now working on a plan of grading the various kinds of coal with regard to quality that came into the Chicago market. Each grade is to be designated by letter and the quality of the coal as shown by proximate analysis is to come within the limitation described for each grade. With proper co-operation between buyer and contractor a satisfactory grading of coal could be effected in this way, so that the buyer could ask for bids on grades A, B or C as may be desired. After receiving the bids the buyer could contract for his coal f. o. b. mine, pay the freight and get the freight bills, which would prove that he was getting the coal that he purchased.

With wagon delivery of coal the buyer should determine the grade of coal desired and so specify in his contract, reserving the right to reject any coal not coming up to the contract grade. With a reputable contractor he will have no trouble. He should, however, have his coal analyzed and if it does not conform with the grades purchased, reject it and order the coal removed. The latter injunction is important, for if the buyer orders the coal removed he punishes the contractor in a way that will not soon be forgotten. It is the big stick in the buyer's hand that will prevent this practice and, if he holds out against scaling of prices to avoid such a penalty or bribery, fair dealing will be insured.

Chicago Section, A. S. M. E., Opens Season

On Nov. 21 at the Morrison Hotel in Chicago Section of the American Society of Mechanical Engineers held its first dinner meeting of the season, with Arthur L. Rice, the new chairman of the section, presiding. A good attendance and short and concise treatment of three subjects of general engineering interest made the opener a lively meeting.

Charles B. Burdick outlined the plans that are now under way to reorganize the Department of the Interior into a Department of Public Works, consolidating under one head all building of the Government, amounting to 20 per cent. of the appropriations made by the Congress. Hitherto this work had been done by thirty different bureaus, twelve to fifteen of them of an engineering character tucked away in various departments foreign to their work. With the head of the department non-technical, proper support and sympathy with the work could not be expected, and as a result there has been a lack of co-operation, needless duplication and delay. Concentrating these various engineering bureaus under one department so that all Government building may be conducted efficiently and with less expense is now the joint work of 74 different engineering societies. At a conference last May in Chicago an organization was perfected to bring about the foregoing. Since that time the Jones-Reavis bill that will make these plans possible has been drafted and in the legislature has been assigned to committees, where it now rests in accordance with the wishes of those responsible for the bill until sufficient public sentiment can be created to put it through.

For the latter purpose there will be a "back-home" campaign in every state of the Union. Each state will have a director and organization to raise money first to conduct the campaign, and then spread publicity on the merits of the bill to every voter in the state, the voter, in turn, to convey his impression to the senator of his respective district.

W. L. Abbott, director for Illinois, reported that the state organization in great detail was now being perfected.

"Results of an Americanization Program," by Alexander D Bailey, was the second topic of the evening. The speaker dwelt upon the need of such a program and outlined briefly the results so far obtained. In simple words, the program consisted of making good American citizens out of our foreign-born. It was a problem requiring full knowledge of American ideals and an aptitude in teaching them. It consisted not only of a matter of schooling, but also prevention of exploitation, good wages, good housing and other factors influencing the welfare of the foreigner. That the foreign-born had not been assimilated in the past was made evident by the radical demonstrations now raging. Their instruction had been left too much to the individual citizen, instead of definite concerted action toward a common end. One of the greatest bars to assimilation was the inability of so many foreigners to talk

English, making them an easy pray for radical propaganda and the more vicious of the foreign language papers. It was surprising to note that of the entire population of Chicago 55 per cent. were either foreign born or not naturalized. To intelligently instruct so great a number in the requirements of good citizenship and bring them into closer acquaintance with our form of government was a task of great magnitude. Mr. Bailey reviewed briefly the work being done along this line and the results obtained by the Commonwealth Edison Company of Chicago.

Charles S. Scribner, in a brief discussion, outlined the principal methods that had been applied successfully to improve human relations. The topic was limited to the relations between the employer and the employe, the principles involved being divided into two groups: those that have to do with the welfare and feelings of the men and those relating to the distribution of wealth between capital and labor. Selection of employes, their surroundings, acquaintance with other workers and their promotion; healthful conditions in the factory, guards against accidents, attitude of foremen, and general relations between the worker and the employer; collective bargaining, an industrial committee made up from the workers and representatives of the employers, shop discipline, wage payment and wage incentive, etc., were some of the various points touched upon by the speaker.

Having outlined the fundamentals of the problem that have to be solved before the present industrial unrest will be subdued, the speaker referred to the industrial democracy plan that is now receiving so much attention.

Among certain of those taking part in the discussion there was a sentiment that the laborer must first show the proper spirit, take a real interest in his work, learn and appreciate industrial democracy, before it was given to him. With radical agitators in full sway many of the workmen would not understand nor would they appreciate a sudden turning to this new scheme. It was a matter that required careful consideration and long hard work in training and instructing employes in the elementary principles involved. When they had assimilated the fact that it was up to them to give fair returns for money received, and when they took a real and intelligent interest in their work, then would be the time to share profits and introduce the plan of industrial democracy.

Naval Architects and Marine Engineers Meet

The Society of Naval Architects and Marine Engineers held its twenty-seventh general meeting at the Engineers' Society Building in New York Nov. 13 and 14.

The council meeting preceded the general meeting and the latter was devoted principally to the presentation and discussion of profession papers. In opening the professional session, the president of the society called attention to the recent enormous growth in American shipbuilding. Referring to past presidential addresses, he noted the satisfaction expressed over the situation in 1900 when 80 steel steam vessels of 168,000 tons were built as compared with Great Britain's figures of 567 vessels of 1,341,000 tons. In 1908 America built 1457 vessels of 614,000 tons, and this was hailed as the greatest output in the history of the country. In the fiscal year 1919 the figures given include only steel steamers of over 1000 tons, but reached the total value of nearly 2,500,000 tons.

The professional sessions occupied Thursday and Friday the 13th and 14th and on Saturday, Nov. 15, a trip to the works of the Submarine Boat Corporation was arranged for members and their guests. The meeting closed with the annual banquet which was held at the Waldorf-Astoria Hotel

DeLamater-Ericsson Memorial

The American Society of Mechanical Engineers with a large number of technical societies and civic organizations will hold a memorial meeting at 8 o'clock on the evening of Dec. 3 at the Engineering Societies Building, 29 West 39th Street, to commemorate the Phœnix Foundry, which stood on West Street between Vestry and Laight Streets, 1838-51, and the DeLamater Iron Works at the foot of West Thirteenth Street, 1851-89, in both of which under Cornelius H. DeLamater and Capt. John Ericsson was developed the progress in naval architecture and industrial engineering which occurred during those years. Tablets will be erected on these sites. People who possess prints or documents relating to these works will confer a favor upon the committee by communicating with H. F. J. Porter, chairman, DeLamater-Ericsson Memorial, A. S. N. E., 29 West Thirty-ninth Street.

Personals

John C. McCabe, commissioner of buildings for the City of Detroit, gave an informal talk before the Detroit Engineering Society, in the auditorium of the Detroit Board of Commerce, on Sept. 19, on the "Detroit Building Code and the Organization of the Building Department."

Franklin W. Gilman, combustion engineer with the Sanford Riley Stoker Co., of Worcester, and the Murphy Iron Works of Detroit, sailed from Vancouver on Oct. 2 for Japan. He will remain in that country for about a year in connection with the installation and operation of stokers manufactured by the two companies.

L. G. Chase, formerly efficiency engineer of the Rosemary Manufacturing Co., Rosemary, N. C., has been appointed mechanical engineer of the Yarnall-Waring Co.

E. H. Martindale has resigned as sales engineer of National Carbon Co. to accept a position as president and general manager of The Handy Supply & Manufacturing Co., Cleveland, Ohio, in which he has been interested in an advisory capacity for three or four years.

A. G. Gibbons, formerly superintendent of tools and supplies of Winslow Brothers Co., Chicago, has affiliated with the Wetmore Reamer Co. in the capacity of production engineer. Mr. Gibbons was also formerly with the Cadillac Co. and Brown & Sharpe for many years.

Nelson B. Gatch has been appointed district manager of sales of the Chicago Pneumatic Tool Co., with headquarters at 52 Vanderbilt Ave., New York City, to succeed L. C. Sprague.

H. W. Philbrook, formerly connected with the General Electric Co., Schenectady, is now district manager of the New York office of Schutte & Koerting Co.

W. D. Hoxie, formerly vice-president of the Babcock and Wilcox Co., New York City, has been elected president.

Business Items

The S-T Engineering Corp., of Buffalo, N. Y., has been incorporated with a capital of one hundred thousand dollars. The company will manufacture and sell mechanical equipment.

The Jacobson Engineering Co., Inc., Albany, N. Y., has opened an office at 30 Church St., New York, which will be the main sales office in future, both for domestic and export business.

The Roller-Smith Co., New York City, announces the appointment of the Alfred Collyer Co., 420 Power Building, 83 Craig St., West, Montreal, Canada, as its agent for the entire Dominion of Canada and Newfoundland. The Alfred Collyer Co. has a branch office at 183 George St., Toronto.

The General Electric Co. has leased the rigid-conduit business of the American Conduit Manufacturing Co. of New Kensington, Penn., which will be conducted by the Sprague Electric Works. There will be no change in the personnel of the American Conduit Manufacturing Co., but the name will be changed to the American Wiremold Co., which will concentrate upon the manufacture of wiremold surface raceway and non-metallic tubing, at Hartford, Conn.

The Chicago Pneumatic Tool Co. has moved its Birmingham office from 801 Brown Marx Building to 1925 Fifth Ave., North, where a service station with a complete stock will be maintained.

The Shipley Construction & Supply Co., Brooklyn, N. Y., has extended its service for industries using refrigerating and ice making equipment, by establishing branch offices at 659 Broadway, Albany, N. Y., and 209 Wood's Building, New Haven, Conn.

The Zobell Electric Motor Corp., Garwood, N. J., is a newly formed corporation which manufactures alternating current and direct current motors, in sizes ranging from 1 to 7½ horsepower.

Trade Catalogs

The Gould's Manufacturing Co., Seneca Falls, N. Y., has issued a 36-page bulletin, No. 122, entitled "Centrifugal Pump Sales Service Data." This was originally issued in a series of sales letters for use in the company's own organization. It contains a lot of information on theory, designs, testing, etc., of centrifugal pumps not published heretofore.

The Taft-Pierce Manufacturing Co., Woonsocket, R. I., has recently issued a nicely finished 47-page bulletin, No. 108, entitled "Take It to Taft-Pierce." It is briefly descriptive of the company's contract service plant, which has engaged in practically every important machine manufacturing development that has taken place in this country. Illustrations are liberally used in the bulletin.

The National Tube Co., Pittsburgh, Penn., has issued its September bulletin, No. 7, which treats of the manufacture and advantages of "National" welding-scale free pipe in a simple interesting way. The bulletin is well illustrated and will be sent to anybody free upon request.

The Yarnall-Waring Co., Philadelphia, Penn., has issued a 22-page bulletin illustrating and fully describing the Yarway-Lea V-Notch Liquid Meter. The booklet is entitled "Boiler Room Records and the Yarway-Lea V-Notch Meter," a copy of which should be in every operating engineer's possession.

The American Steam Conveyor Corp., Chicago, Ill., has issued a folder entitled "A Pertinent Ash Pile Question," which advances arguments favoring the use of its steam ash conveyor in power plants, and shows the savings that can be accomplished through its use.

The Alberger Pump and Condenser Co., New York City, has issued a 63-page catalog "F" on "Alberger Centrifugal Pumps and Curtis Steam Turbines," which illustrates and fully describes the various types manufactured by this company.

New Construction

PROPOSED WORK

Ala., Gadsden—The city plans an election to vote bonds for the construction of an electric distribution system. E. Smith, City, Engr.

Conn., Bridgeport—The Columbia Grafanola Co., Barnum St., plans to build a 5 and a 6 story factory on Barnum St. and Howard Ave. A steam heating system will be installed in same. Total estimated cost, $1,750,000.

Conn., New Haven—The city voted $500,000 bonds to erect an ice plant.

Cal., San Francisco—C. R. McCormick & Co., Fife Bldg., desires to purchase Babcock-Wilcox boilers.

Ia., Iowa City—The State Board of Control, Hubbell Bldg., Des Moines, is having plans prepared for the construction of a 3 story, 60 x 130 ft. nurses' home. A steam heating system will be installed in same. Total estimated cost, $150,000. Proudfoot, Bird & Rawson, Hubbell Bldg., Des Moines, Arch.

Ia., Iowa City—The State Board of Education, Des Moines, is having plans prepared for the construction of a 3 story, 90 x 180 ft. armory, here. A steam heating system will be installed in same. Total estimated cost, $200,000. Proudfoot, Bird & Rawson, Hubbell Bldg., Des Moines, Arch .

Ia., Larabee—The Board of Education is having plans prepared for the construction of a 3 story, 82 x 139 ft. school. A steam heating system will be installed in same. Total estimated cost, $130,000. H. Montgomery, Secy. W. E. Hulse & Co., 210 Masonic Temple, Des Moines, Arch.

Ia., Olds—The Board of Education is having plans prepared for the construction of a 2 story, 62 x 150 ft. consolidated school. A steam heating system will be installed in same. Total estimated cost, $110,000. J. E. Stuckey, Secy. Keffer & Jones, 204 Masonic Temple, Des Moines, Arch.

Ia., Sioux City—The Sioux City Hotel, c/o W. Gordon, is having plans prepared for the construction of an 8 story, 150 x 150 ft. hotel on 7th and Pierce Ave. A steam heating system wil be installed in same. Total estimated cost, $1,500,000. Marshall & Fox, 721 North Michigan Ave., Chicago, Ill., Arch.

Kan., Emporia—The State Board of Education, Topeka, is having plans prepared for the construction of a 1 story power plant, including equipment, for the State Normal School, here. Estimated cost, $70,000. J. A. Kimball, Mgr.; R. L. Gamble, 1415 Fillmore St., Topeka, Arch.

Ky., Frankfort—The Capitol Hotel Co. will receive bids until December 1 for the construction of a 5 story hotel. A power plant will be installed in same. Total estimated cost, $200,000. C. C. Weber, 3rd and Walnut Sts., Cincinnati, Ohio, Arch.

Md., Baltimore—The Kaufman Beef Co., Union Stockyards, 6th St. near Wilkens Ave., is having plans prepared for the construction of a 2 story, 40 x 150 ft. packing house and power house. A steam heating and electric lighting system, elevators, refrigerators, etc., will be installed in same. Total estimated cost, $100,000. C. H. A. Wannanwetsch, 563 William St., Buffalo, N. Y., Engr.

Md., Baltimore—The Misken Israel congregation is having plans prepared for the construction of a 2 story, 50 x 130 ft. synagogue at 2310 Madison Ave. A steam heating system will be installed in same. Total estimated cost, $150,000. A. Kress, 2318 Eutaw Pl., Pres. Stanislaus Russell, 11 East Lexington St., Arch.

Md., Baltimore—The City Council is having plans prepared for the construction of a 1 story fire house on Lexington St. near Gay St. A steam heating system will be installed in same. Total estimated cost, $150,000. A. Osborn, City Hall, Arch.

Md., Sparrows Point—The Bethlehem Ship Building Corporation plans to construct a dry dock, to be driven by electric power. Swen Anderson, Gen. Mgr.

Mass., Boston—The Merchants National Bank., 28 State St., will receive bids this winter for the construction of a 5 story, 54 x 222 ft. bank addition on Devonshire St. A steam heating system will be installed in same. Total estimated cost, $500,000. Coolidge & Shattuck, 122 Ames Bldg., Arch.

Mass., Chicopee—The Springfield Coach Works, 59 Dwight St., will alter present factory and build a boiler house on North Main St. Two boilers will be installed in same. Work will be done by day labor. Total estimated cost, $25,000.

Mass., North Adams—The Y. M. C. A., 2 West 45th St., New York City, is having plans prepared for the construction of a building, here. A steam heating system will be installed in same. Total estimated cost, $250,000. Jallade & Lindsey, 37 Liberty St., New York City, Arch. and Engr.

Mich., Detroit—The General Motors Corporation, 435 Woodward Ave., is having plans prepared for the construction of a 26 x 26 ft. pump house, also furnishing and installing 5 motor driven oil pumps for circulating oil in the heat treating and hardening plant. Esselstyn, Murphy & Hanford, Marquette Bldg., Engr. Noted June 3.

Mich., Detroit—The Board of Education, 50 Broadway, is having plans prepared for the construction of the Park School, Milwaukee Ave. and East Grand Blvd.; Greusel School, Moran and Medbury Ave., and Capron School, Maple and Riopelle St. The plenum system of heating will be installed in same, boiler, pump, fan and motor involved in each case. Total estimated cost, $150,000. Malcolmson & Higginbotham, 405 Moffat Bldg., Arch.

Mich., Detroit—S. E. Remey, Arch., 503 Whitney Office Bldg., is preparing plans for the construction of a 6 story, 47 x 52 ft. office building on Hastings and Erskine Ave. A steam heating system will be installed in same. Total estimated cost, $100,000. Owner's name withheld.

Mich., Detroit—The Superior Machine & Engineering Co., East Larned St., is having plans prepared for the construction of a 5 story, 100 x 104 ft. factory. Steam heating equipment and electric motors for power will be installed in same. Brown & Preston, 406-8 Empire Bldg., Arch.

Mich., Detroit—The John R. Thompson Auto Co., Woodward Ave., has retained Albert Kahn, Arch., Marquette Bldg., to prepare plans for the construction of a 2 story, 400 x 700 ft. commercial auditorium on Woodward and Cass Ave. A ventilating system and steam heating equipment, with accessories, will be installed in same. Total estimated cost, $2,500,000.

Mich., Ferndale—G. D. Bader, 3002 Woodward Ave., will build a 2 story, 80 x 100 ft. commercial building on Woodward Ave. A steam boiler for heating purposes will be installed in same. Total estimated cost, $60,000. Work will be done by day labor.

Mich., Grand Rapids—The Regent Theatre Co., Bond St., is having plans prepared for the construction of a 3 story, 100 x 100 ft. theatre on Crescent and Bond St. A steam heating system will be installed in same. Total estimated cost, $300,000. George M. Lindsey, 2321 Dime Bank Bldg., Detroit, Arch. and Engr.

CONTRACTS AWARDED

Cal., Los Angeles—The University of Southern California, College of Liberal Arts Bldg., 35th and University St., has awarded the contract for the installation of a heating and ventilating system in connection with the proposed 3 story college building, to Thomas Haverty Co., 9th St. and Maple Ave., $27,980.

Conn., Willimantic—The State Board of Education has awarded the contract for installing a heating system, in the proposed 3 story dormitory on Valley St., to R. R. Bell & Co., 59 Fort St., Springfield, Mass. Noted Feb. 4.

Ill., Amboy—The Amboy Milk Products Co. has awarded the contract for the construction of a 2 story, 97 x 153 ft. condensory to the Appleton Construction Co., Odd Fellows Bldg.

Ia., Muscatine—The Masonic Lodge has awarded the contract for installing a steam heating system in the proposed 3 story, 55 x 120 ft. Masonic Temple, to the percentage Lotspeich Co., Muscatine. Total estimated cost, $120,000.

Kan., Willis—The city has awarded the general contract for the construction of a distribution system and a transmission line from here to Horton, to C. R. McConnel, Horton, $18,490; transmission and motors to C. L. Millbank, Interstate Bldg., Kansas City, Mo., $1350. Noted Sept. 30.

Md., Baltimore—A party of capitalists of Richmond, Va., and Washington, D. C., have awarded the contract for the construction of an 18 story, 180 x 250 ft. hotel on Charles and Chase St., here, to the Wise Granite & Construction Co., American National Bank, Richmond, Va. Subbids to be let on steam heat, electric light, elevators, vacuum cleaning, refrigerators, etc. Total estimated cost, $1,500,000.

Mass., Springfield—The United Manufacturing Co., 57 Willow St., has awarded the contract for the construction of a 1 story boiler room on Birnie Ave. to D. W. Mellen, 293 Bridge St. Estimated cost, $25,000.

Mich., Birmingham—The city is having plans prepared by C. W. Hubbell, Engr., 2348 Penobscot Bldg., Detroit, for the construction of a water system consisting of 12 in. wells and two motor driven centrifugal pumping units, etc. Total estimated cost, $75,000.

Mich., Detroit—The Detroit Edison Co., David Whitney Bldg., has awarded the contract for the construction of a 2 story, 100 x 207 ft. service station on Ledyard and 2nd St., to the Albert A. Albrecht Co., 1130 Penobscot Bldg. A steam heating system will be installed in same.

Mich., Detroit—The Eastern Motor Sales Co., 404 Gratiot Ave., has awarded the contract for the construction of a 3 story, 115 x 143 ft. service station on Gratiot Ave., to the Otto Misch Co., Chamber of Commerce, Detroit. A hot water heating system will be installed in same. Total estimated cost, $50,000.

Mich., Detroit—The Fisher Body Corporation, Oakland Ave. and Piquette St., has awarded the contract for the construction of a 1 story, 57 x 64 ft. power house on Theodore and Riopelle St., to G. A. Fuller Co., 540 Penobscot Bldg. Two vertical boilers, 250 h.p. each, will be installed in same. Total estimated cost, $45,000.

Mich., Detroit—The Fisher Body Corporation, Oakland Ave. and Piquette St., has awarded the contract for the construction of a 1 story power house, on Trombley St., to Montague & Forney, 813 Ford Bldg. Total estimated cost, $80,000.

Mich., Detroit—The General Aluminum & Brass Manufacturing Co., St. Aubin Ave., has awarded the contract for the construction of a 1 story, 60 x 75 ft. power house, on St. Aubin Ave. and Boulevard, to the Carlton Construction Co., St. Aubin Ave. Two 250 h.p. Wickes boilers will be installed in same.

Ohio, Cleveland—The White Sewing Machine Co., East 79th St. and St. Clair Ave., has awarded the contract for the construction of a 1 story, 32 x 40 ft. temporary boiler house, to the Watson Engineering Co., 1101 Hippodrome Bldg. Estimated cost, $7000.

Mich., Detroit—The Burroughs Adding Machine Co., 2nd and Burroughs Ave., has awarded the contract for the construction of a 2 story, 97 x 99 ft. boiler room, to A. J. Smith Construction Co., Campaw Bldg. Two boilers and condensers, three turbine engines and one conveyor will be installed in same.

Mich., Saginaw—The Michigan Crankshaft Co. has awarded the contract for the construction of a 1 story, 160 x 690 ft. crankshaft plant on Genesee Ave. and Pere Marquette Railway, to W. F. Wood Co., 1805 Ford Bldg., Detroit. Plants include a 50 x 94 ft. power plant, containing two 500 h.p. boilers, with coal crusher, automatic stokers, engines and pumps. Total estimated cost, $600,000.

Wis., Milwaukee—The Gridley Dairy Co., 138 8th St., has awarded the contract for the construction of a 39 x 55 ft. boiler house, at 1325 North Ave., to Dahlman Construction Co., Majestic Bldg. Estimated cost, $15,000.

Wis., Milwaukee—Robert A. Johnson Co., 270 Florida St., has awarded the contract for the construction of a 1, 2, and 3 story, 120 x 185 ft. power house and garage, on 34th St. and National Ave., to Paul Riesen's Sons, 1018 Humboldt Ave. Steam heating and power equipment will be installed in same. Total estimated cost, $90,000.

Ia., Creston—The Board of Education has awarded the contract for installing a steam heating system in the proposed 2 story, 52 x 81 ft. school, to R. C. Wilbee, Creston, $15,823.

Minn., Fairmont—The city has awarded the contract for the construction of a 1 story, 83 x 83 ft. electric power house, to J. G. Robertson, 2528 University Ave., St. Paul. Estimated cost, $175,000. Noted September 30.

Kan., Pretty Prairie—The city has awarded the contract for furnishing and installing pumps, in connection with the proposed water works system, to the American Well Works Co., 319 Reliance Bldg., Kansas City, Mo., $2722.

H. T., Pearl Harbor—The Bureau of Yards & Docks, Navy Department, Washington, D. C., has awarded the contract for the construction of a boiler house, to C. L. Wold Co., 40 Montgomery St., San Francisco, Cal., $363,889.

Ont., London—J. and J. Allen, Richmond and Victoria Sts., Toronto, have awarded the contract for the installation of a vacuum steam, electric operated blower ventilating system in the proposed 1 story 100 x 180 ft. motion picture theatre, to A. Welsh & Son, Ltd., 304 Queen Ave., Toronto. Noted April 8.